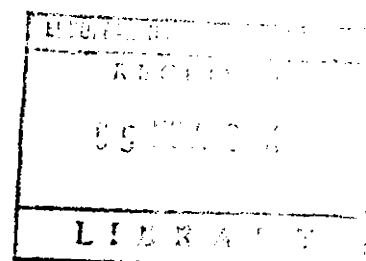




EUROPEAN UNIVERSITY INSTITUTE
Department of Economics



Three Essays on Law and Economics

Steven Tokar

*Thesis submitted for assessment with a view to obtaining
the degree of Doctor of the European University Institute*

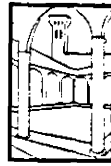
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1. INTRODUCTION

This thesis is composed of three papers that analyse the interaction of law and economics. The first paper is a study of the attempts to use whistleblowers to control corporate crime. The paper asks which type of reward system is likely to promote welfare enhancing levels of whistle-blowing: large rewards will tempt more whistleblowers, but some of these may have fabricated the evidence in the hope of misleading the courts. The optimal level of rewards depends on the accuracy of the legal system, and if the legal system never makes mistakes then corporate crime can be eradicated. In the second paper the focus shifts from the individual to the firm and to opportunities for profiting in the stock market. The paper comes in two parts. The first investigates predation when the predator can take short positions in the shares of the preyed firm. The second part investigates the effect of long and short positions in one's competitors' shares on cartel stability. In the third paper I return to the individuals within a law breaking firm, but this time I concentrate on the executives and their remuneration. The paper empirically tests whether the executives in firms that breached the UK competition laws were compensated for the extra risks inherent in breaking the law. In the rest of this introduction I describe each paper in more detail.

The paper on whistleblowing is contained in Chapter Two, and analyses the potential effectiveness of using employee whistleblowers to counteract corporate crime. The paper was inspired by the success of the False Claims Act in the US, which has led to a large number of firms being convicted of defrauding the government and over 4 billion dollars of fines have been levied. The Act contains a *qui tam* system that allows individuals to file cases against those who have defrauded the US government, their reward being a proportion of any fine imposed. The paper gives a description of the Act and models the choices of the actors. The results show that a number of factors will be critical to the success or failure of the False Claims Act. Initially I follow the work of Besanko and Spulber, (1989) and assume that the court system is perfect, so the evidence presented in court sends a perfectly informative signal to the judge about the actions of the firm. Under this assumption it is possible to eliminate corporate crime at zero cost. This contrasts with the results of Besanko and Spulber (1989), who find that some positive level of crime always occurs. However, the assumption of no court errors is not very plausible and it is more realistic to assume that the signal given by the evidence in court is not perfectly informative. In this case the results are not clear-cut. The possible outcomes depend on the interplay of two factors: the quality of

the court's signal and the level of the reward. If rewards are too low then the employee will never file, leading to the firm acting illegally as there is no chance of being prosecuted. With relatively un-noisy signals and sufficiently high rewards the employee will not file a case against a firm that has acted legally but will credibly threaten to file against a firm that acts illegally. The threat of being fined makes it optimal for the firm to act legally. If rewards are too high and the signal given by the evidence is noisy then the employee is likely to file cases against illegally and legally acting firms. The result of this is that the firm will act illegally in order to gain the benefit of the crime.

The second chapter deals with outsider trading. Outsider trading occurs when a firm trades in the shares of other firms when it knows that its own actions will affect the share prices of those other firms. An example would be the case where a supermarket was about to launch a price war and reduce the prices of its goods. It is likely that the announcement of this price war would reduce the share prices of its publicly quoted competitors. If the supermarket starting this price war were to take short positions in the shares of its competitors before it announced the strategy this would be a case of outsider trading. The decision of Halifax, a UK building society, to reduce the standard interest rate on its mortgages from 7.5% to 6.75% on Tuesday 20th of March 2001 provides a real life example of an outsider trading opportunity. The table below gives the changes in the share prices of Halifax's main competitors in the two days following the announcement:

Table 1.1
Share Price Changes in March 2001

Company	Opening Price 20/2/01	Closing Price 21/2/01	% Change
Abbey National	1173	1114	-5.02
Alliance and Leicester	709	675	-4.79
Barclays	2308	2214	-4.04
Bradford and Bingley	300.75	296	-1.58
HSBC	1056	1034	-2.08
Lloyds-TSB	670.5	637	-5.00
Royal Bank of Scotland	1703	1532	-10.04

As one can see, were Halifax to have taken a short position in the shares of its competitors, and or bought some puts, it could have profited handsomely. The paper discusses the strategic value of these outsider trading opportunities and the results show that the role of these outsider trading opportunities is similar to the role of capacity investment in Dixit (1980), in that outsider trading shifts the reaction function of the trading firm. Dixit (1980) studies entry deterrence; here I study predation and cartel stability. In the predation model I show how the ability of a predator to take a short position in the shares of the target firm can lead to the predator overcoming the standard commitment problem. The predator's gain from the fall in the target's share price makes the predator's threats credible and rational. Under certain conditions the equilibrium results in the target firm exiting the market as soon as it learns of the predation strategy. However, the results are heavily affected by the whether the products are strategic substitutes or strategic complements. The second half of the paper deals with the stability of cartels when cartel members can trade in the shares of their competitors. The results show that the outsider trading always makes cartels less stable. Various potential explanations for these results are discussed.

Chapter Four contains a paper that investigates firms that broke the UK competition laws and specifically the remuneration of the executives in those firms. The hypotheses tested centre around whether these executives received higher remuneration to compensate them for the risks involved in breaking the law. The results show that both the highest paid executive and the board of directors in firms that broke the law received significantly higher remuneration than a comparison sample. Similar tests were run on a sample of firms after they were reprimanded, when they are presumed to be no longer breaking the law. These results are less conclusive. While the highest paid directors did not receive higher remuneration total board remuneration was still significantly higher in the firms that were previously reprimanded.

2. WHISTLEBLOWING AND CORPORATE CRIME

2.1. Introduction

In this chapter I analyse the potential effectiveness of using employee whistleblowers to counteract corporate crime. This is the system employed by the False Claims Act 1986 (USC 31 § 3729-3733). The Act allows individuals to take anyone to court if they are making false claims against the government, with the reward being a share of any fine imposed on the indicted party. The use of rewards differentiates the legislation from other whistleblower laws. These other statutes, like the US Civil Service Reform Act of 1978 and the US Whistleblower Act of 1989, only attempt to protect the whistleblower from harassment and revenge attacks.¹

The legal process is quite intricate and begins when an individual or individuals, henceforth called the relator, files a complaint against a firm 'in camera'. This means that the complaint is not immediately served upon the firm, in this case for at least 60 days. In this time the relator remains anonymous and the Department of Justice (DoJ) must investigate the complaint. The complaint will contain information about an alleged fraud against the US government and will implicate some parties. After investigating the DoJ decides on a course of action. It has four options: dismiss the case, offer to settle the case out of court, allow the relator to proceed alone, or intervene and go to court.

If the DoJ intervenes then it takes primary responsibility for the prosecution and the relator remains as a party to the case. The case then proceeds as a normal fraud investigation. In this instance the relator receives between 15% and 25% of any successful recovery. The exact percentage is decided by the judge and depends on the contribution of the relator to the successful prosecution of the case.

If the government does not intervene the relator is solely responsible for the prosecution of the case and must bear all the prosecution costs. If the relator wins the case without the aid

¹ The use of rewards also differentiates the legislation from 'gatekeeper legislation'. Gatekeeper legislation imposes liabilities on those parties whose cooperation is necessary for fraud to succeed. Requirements of this type are in the US Securities Act of 1933 §11 of this statute forces the parties involved in the sponsoring of a public share offering to reasonably investigate the validity of the new firm. See Kraakman (1986).

of the DoJ then the relator is awarded between 25% and 30% of the damages paid by the defendant.

Apart from legal costs, the other major cost of filing a *qui tam* suit is the possibility of dismissal. Since the employee may fear retaliation if they file a *qui tam* suit against their employer there are specific protective measures contained in the Act. Section 3730(h) attempts to protect whistleblowers from retaliation, promising twice the amount of lost pay, compensation, and reimbursement of any legal fees expended when suing the firm under § 3730(h).

While the laws that attempt to solely protect whistleblowers from retribution have had little success in increasing the amount of fraud reported the False Claims act has, ostensibly, been very successful.² It seems to be an expedient way of combating crime in areas where detection is difficult. Detection problems are especially prominent in the area of fraud against the US government, where it is impossible for the auditors to cross check every Medicaid or Medicare invoice. In contrast, it is likely that the employee filling out the form knows whether the claim is fraudulent. If the employee can be induced to truthfully reveal when the company is defrauding the government then it would appear that the False Claims Act is the perfect system for stamping out fraud. Is this the case? The False Claims Act raises two main questions:

1. Will employees actually file when they discover a fraudulent claim?
2. If they do file will they only file against firms which have actually committed fraud?
Or will they invent claims in the hope of obtaining judicial rewards?

The model presented here shows that a number of factors will be critical to the success or failure of the False Claims Act. Firstly, if the court system is perfect and the evidence presented in court sends a perfectly informative signal to the judge about the actions of the firm then it is possible to eliminate fraud at zero cost. Unfortunately, this is not very plausible and a more realistic assumption is that the signal given by the evidence in court is not perfectly informative. In this case the results are not clear cut. The possible outcomes

² *Qui tam* recoveries exceed \$4.174 billion, with over 3,326 *qui tam* cases filed since the False Claims Act was amended in 1986. Source: Taxpayers Against Fraud Website: <http://www.taf.org/> Consulted October 2001.

depend on the interplay of two factors: the quality of the court's signal and the level of the reward. If rewards are too low then the employee will never file, leading to the firm acting illegally as there is no chance of being prosecuted. With relatively un-noisy signals and sufficiently high rewards it is possible to deter firms from committing fraud. The employee will not file a case against a firm which has acted legally but will credibly threaten to file against a firm which acts illegally. The threat of being fined makes it optimal for the firm to act legally. If rewards are too high and the signal given by the evidence is noisy then the employee is likely to file against illegally and legally acting firms. The result of this is that the firm will act illegally in order to gain the benefit of the fraud.

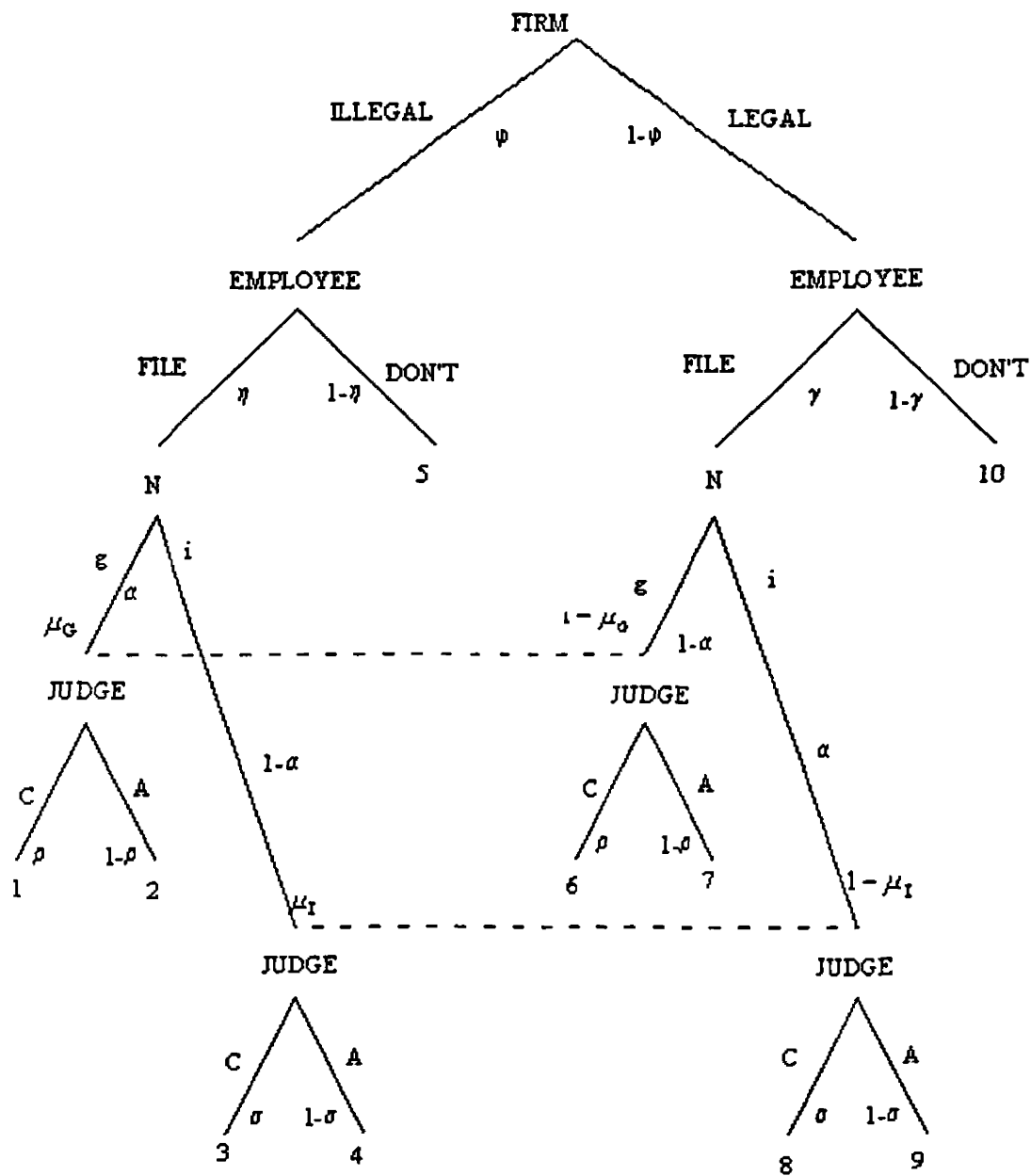
In studying the area of delegated monitoring and whistleblowing this paper is similar to the work of Instefford et al. (1998). They model the internal structure of the firm as a monitoring chain and show that raising the payoffs to whistleblowers can reduce the amount of fraud in a firm. The main difference between their paper and this one is that they discuss only internal monitoring and concentrate on the whether *ex ante* or *ex post* regulatory activity is superior. Another related paper is that of Motta and Polo (1999). They study the problem of trying to entice a firm to admit that it was part of a cartel, analysing leniency policies that give fine reductions for admitting guilt. Their focus is on the incentives for the entire firm to whistleblow rather than the incentives for the employee.

The rest of the paper is laid out as follows. Section two describes the model. Section three discusses the results and the equilibria that are possible. The results for a restricted version of the model where the costs of fabricating evidence are set to zero are presented in section four. The conclusion ends the paper.

2.2. The Model

The model described below is a dynamic game of imperfect information. The game has three players: the firm; the employee; and the judge.³ All players wish to maximise their expected payoff and are risk neutral. The structure of the game, the payoffs and the players' rationality are all common knowledge. The extensive form of the game is shown in Figure One.

Figure One
EXTENSIVE FORM OF MODEL



³ The possible interjection of the Department of Justice is not included as it only complicates the model and leaves the main results unchanged.

The timing of the game is as follows.

1. The firm chooses whether to commit the fraud or not. If the firm acts illegally then it obtains a return of Π . The profits from acting legally are standardised to zero. I use the term fraud here in order to lend some specificity to the description and because it is the standard case under the False Claims Act. The model can be thought of as covering any type of corporate crime.
2. The employee then decides whether to file a case against the firm or remain silent. The employee's information sets are singletons, the employee knows whether the firm committed the crime or not. If the employee remains silent his payoff is zero - irrespective of whether the firm acted illegally or legally. If the employee decides to file a case he must pay a cost $C > 0$. The most obvious cost of filing a case is attorney's fees, although standard practice is to enter into a contingency fee agreement where legal fees are only paid if the case is won.

Since the standard False Claims Act case is the employee filing a case against his employer, the other major cost is the possibility of dismissal. In order to try and prevent retaliation the Act contains a clause protecting whistleblowers. Although this clause promises twice back pay and compensation there is still legal debate within the US court system as to the applicability of this clause. If, as is likely, the relator is dismissed then he must estimate the present value of lost income, discounting at an appropriate rate and factoring in the possibility of promotion and or periods of unemployment. Although these costs will be incurred in the future, they are a direct consequence of the decision to file a case, and the change in expected income occurs when the relator decides to file the case. In sum, it is clear that there a strictly positive cost is incurred when the relator files a *qui tam* case.

In addition to the costs of filing, if the firm is innocent the employee incurs a cost of $t > 0$ when fabricating the evidence against the firm. This cost relates to the time and effort spent fabricating the evidence, as opposed to just collecting the evidence in the firm. t can also be thought of as the increased risk of a fee-shifting judgement. Section 3730(d)(4) of the Act states:

"If the government does not proceed with the action and the person bringing the action conducts the action, the court may award to the defendant its reasonable attorneys' fees and expenses if the defendant prevails in the action and the court finds that the claim of the person bringing the act was clearly frivolous, clearly vexatious, or brought primarily for purposes of harassment."

Therefore part of t can be thought of as the increased probability (increased w.r.t. bringing a genuine case) of having to pay the legal fees of the firm.

While the costs of filing the case are certain, the positive returns are not guaranteed. The employee will only receive a proportion $0 < b < 1$ of the fine F ($F > \Pi$).⁴ if the judge condemns the firm. In reality the level of b will depend on the relator's contribution to the case, and is decided upon by the judge. Here one can think of b as the proportion of the fine the relator expects to receive. With regard to the fine F , the legislation lays out the exact rules for calculating the fine. Section 3729(a)(7) states that the defendant:

"is liable to the United States Government for a civil penalty of not less than \$5,000 and not more than \$10,000, plus 3 times the amount of damages which the Government sustains..."

Given the relator knows about the crime it is reasonable to assume that the value of F is also known to the employee.

3. If the employee files a case the next move is that of nature. The move of nature represents all the evidence that appears in court. The evidence comes from the firm and the relator, but could also come from other sources such as police reports or government investigations. The evidence presented to the judge gives her a signal about the guilt or innocence of the firm. The signal can take on two discrete outcomes, $s \in \{g, i\}$. Here g means that the evidence points to the firm being guilty, i.e. it acted illegally, and i means that the evidence points to the firm being innocent,

⁴ When $\Pi \geq F$ the firm will always act illegally. This case is not interesting so I ignore it.

i.e. the firm played legal. This signal is assumed to be informative but not perfectly informative and the signal is correct with a probability of α , $1 \geq \alpha \geq \frac{1}{2}$. For example, if the firm chose illegal then $s = g$ with probability α and $s = i$ with probability $[1-\alpha]$. The judge uses this signal to update her beliefs about the guilt or innocence of the firm. She is not bound by it, even if the signal is $s = i$ her best response may still be to condemn the firm.

4. The final move is that of the judge. The judge has imperfect information about the move of the firm. The judge cannot observe the move of the firm and therefore updates her beliefs about which node she is at using Bayes' Rule. The judge's two information sets represent the result of the court signal: guilty or innocent. The judge receives the signal about whether the firm is guilty or innocent but is not able to tell with certainty whether the firm actually committed the crime or not. The judge has two possible moves at every node: she can condemn or acquit the firm. If the judge condemns the firm then the firm is fined F and the employee receives a proportion of the fine. If the judge's move is acquit then the firm is not fined and the employee receives no reward. The four possible outcomes are condemning a firm that acted illegally, condemning a firm that acted legally, acquitting a firm that acted illegally and acquitting a firm that acted legally. I assign the following utilities: if the judge is correct, i.e. she condemns a firm which acted illegally or acquits a firm which acted legally, then she receives a payoff of 1 if the judge gives the wrong verdict she receives -1.⁵ The use of judge utilities makes the standard of guilt endogenous in the model. The general equation used for calculating the level of belief necessary to convict the accused is:

$$P = \frac{U_a^{LE} - U_c^{LE}}{U_c^{LE} + U_a^{LE} + U_c^{LE} - U_a^{LE}}$$

Where U_a^{LE} refers to the utility of acquitting a firm which acted legally and U_c^{LE} refers to the utility of condemning a firm which acted illegally, etc. Substituting the values

⁵ The subject of the utility of these outcomes has been heavily debated in the literature. See: Andreoni (1991), Connolly (1987) Kaplan (1968), Milanich (1981) and Tribe (1971). In any case the results are not dependent on this assumption.

above gives $p = 0.5$. In civil law the standard of proof is deemed to be a 'preponderance of the evidence' and it is generally acknowledged that this is equal to 0.5. Whichever party offers the most convincing case, i.e. which of the versions presented seems closer to the truth, wins. In the model I adopt this standard and the judge will play a pure strategy of convict if her updated Bayesian belief that the firm acted illegally is strictly larger than 0.5.

2.3. Strategic Form

The payoff structure is given in Table 2.1.

Table 2.1
Payoff Table

Node	Firm Payoff	Relator Payoff	Judge Payoff
1	$\Pi - F$	$bF - c$	1
2	Π	$-C$	-1
3	$\Pi - F$	$bF - c$	1
4	Π	$-C$	-1
5	Π	0	0
6	$-F$	$bF - C - t$	-1
7	0	$-C - t$	1
8	$-F$	$bF - C - t$	-1
9	0	$-C - t$	1
10	0	0	0

Given this structure the solution concept chosen to solve the game is sequential equilibrium, as promoted by Kreps and Wilson (1982). In many cases in this model the requirements for sequential equilibria are identical to those imposed by weak perfect Bayesian equilibrium. The extra restriction imposed by the sequential equilibrium concept concern beliefs at nodes which are off the equilibrium path, i.e. nodes which are reached with zero probability in equilibrium. By using sequential equilibrium instead of weak perfect Bayesian equilibrium I restrict the possible strategies of the judge when her decision nodes are not reached. These

restrictions mean that the set of sequential equilibria is a subset of the set of weak perfect Bayesian equilibria.

There is no unique solution to this game. Under some parameter conditions there are unique equilibria, but there are also cases when a set of parameter values leads to a number of different possible equilibria. In these cases it is difficult to predict what the outcome of the game would be.

The method followed to obtain the equilibria was as follows. First, I selected a set of beliefs for the judge, e.g. $\mu_G > 1/2$ and $\mu_I > 1/2$. From this one obtains the best responses of the judge and one can then move up the tree and obtain the optimal strategies for the employee and the firm. Once all the best replies are calculated it is possible to re-derive the judge's beliefs to see if they are compatible with the initial choice. If they are then the beliefs and strategies are a sequential equilibrium.

Before diving into the main model I solve for the case of $\alpha = 1$. This is the situation where the evidence presented in court gives a perfect signal about whether the firm acted illegally or not. Although perhaps unrealistic it serves for expositional purposes and as a benchmark for the standard model. Furthermore, $\alpha = 1$ means that the firm's actions are verifiable information. This allows a direct comparison with earlier papers using this assumption, in particular the papers of Besanko & Spulber (1989) and Martini (1995). They tackle the problem of collusion, but collusion can be thought of as one of the corporate crimes covered by this paper. All that is needed is the assumption that the action is illegal and that it gives some benefit to the firm.

2.4. Analysis With Perfectly Informative Signal ($\alpha = 1$)

Proposition - If $bF > C$ then the unique sequential equilibrium is for the firm to play legal and the employee to play not file if the firm acted legally.⁶ The employee credibly threatens to file if the firm plays illegal. Furthermore, for a sequential equilibrium we must specify the beliefs of the judge and which actions she will take even though her nodes are off the

⁶ Technically, sequential equilibrium is not defined for this degenerate case of the model since when calculating consistency of beliefs one should also consider the moves of nature as containing errors. This slight lack of formality does not affect the results.

equilibrium path. With $\alpha = 1$ her beliefs are $\mu_G = 1$ and $\mu_I = 0$, leading her to condemn on a guilty signal and acquit on an innocent signal. The equilibrium can be described in the following way:

$$\varphi = 0, \eta = 1, \gamma = 0, \rho = 0, \sigma = 0, \mu_G = 1, \mu_I = 0$$

Where:

φ is the probability that the firm acts illegally.

η is the probability that the employee files given that the firm acted illegally.

γ is the probability that the employee files given that the firm acted legally.

ρ is the probability that the judge condemns on a guilty signal.

σ is the probability that the judge condemns on an innocent signal.

μ_G is the probability of being at the left hand node of the guilty signal information set.

μ_I is the probability of being at the left hand node of the innocent signal information set.

Proof - As is normal, we start at the bottom of the tree and work our way up. With $\alpha = 1$ the beliefs of the judge are trivial. Given that the signal from the evidence is perfectly informative the judge will always condemn on a guilty signal and acquit on an innocent signal. With this decided one can now move up the tree to the decision nodes of the employee. If the firm chose illegal then the employee is choosing between a payoff of $bF - C$ and zero. By assumption $bF - C > 0$ so the employee's best response is to file. If the firm acted legally then the employee is choosing between $-C - t$ and zero (the firm will be acquitted so there will be no reward). The employee's optimal response is therefore not to file a case against a firm that acted legally.

We can now move up to the initial node of the firm. The firm chooses between legal, which leads to a payoff of $\Pi - F$ and illegal, which leads to a payoff of zero. Given the parameter conditions it is optimal for the firm to choose legal. ■

Proposition 2 If $bF < C$ then the unique sequential equilibrium is for the firm to choose illegal and the employee not to file whatever the firm does. As before $\mu_G = 1$ and $\mu_I = 0$. The judge will condemn on a guilty signal and acquit on an innocent signal. The equilibrium can be described in the following way:

$$\varphi = 1, \eta = 0, \gamma = 0, \rho = 1, \sigma = 0, \mu_G = 1, \mu_I = 0$$

Proof The proof follows the same lines as the one given above. The only difference is that the reward bF is too small to entice the employee to file. With no one filing it is optimal for the firm to act illegally. ■

The results above show that the use of *quit tam* suits allows us to obtain the first best equilibrium of no illegality providing two conditions are met: first, the signal given by the court is perfectly informative about whether the firm acted legally or illegally; second, the rewards are large enough to entice relators to file.

2.5. Comparison With Earlier Papers

This result differs from that of Besanko & Spulber (1989) and Martini (1995). In both of these papers the results obtained show that allowing some collusion is optimal.

In Besanko & Spulber (1989) a small degree of collusion is optimal because it saves enforcement costs and stops more serious levels of collusion (Proposition Two in their paper). In Martini (1995) a little collusion results from the lack of pure strategy equilibria when legal costs are low (Proposition Two in his paper). A pure strategy of prosecute would lead to total deterrence but would waste legal fees as the firms would never collude. The unique equilibrium exists when the authority and the firm play mixed strategies, thus implying some strictly positive level of collusion in equilibrium.

In these two previous models full eradication of collusion is therefore not optimal. In the model studied here full eradication of fraud (collusion) is possible and optimal (if one assumes that zero corporate crime is optimal). The different result here comes from the fact that in this model when the employee makes the decision to prosecute the employee knows whether the firm acted illegally or not. In both the other models when the authorities make the decision to prosecute they are still unaware of whether the firm acted illegally or legally.

In Besanko & Spulber the authority prosecutes because it is carrying out the strategy it pre-committed to. In Martini the decision to prosecute is taken after the firm has committed the crime but when the authority is still unaware of whether the firm acted illegally or not. The use of relators allows this Gordian Knot to be cut and leads to the prosecution of only those firms which acted illegally. Full deterrence is thus optimal and possible when the signal of the court system is perfectly informative (when $\alpha = 1$) and the *qui tam* payoffs are high enough to entice employees to file (when $bF > C$).

2.6. Analysis With Imperfectly Informative Signal ($1/2 < \alpha < 1$)

In this section I discuss the results of the main model where the signal given by the court system is not perfectly informative ($1/2 < \alpha < 1$). But before I do this I detail the proof for an equilibrium. The equilibrium chosen corresponds to that of equilibrium one, the correct filing equilibrium. The proofs for the other equilibria are similar and so I omit them.

Proposition 3 (Equilibrium One, correct filing equilibrium)

Under the parameter conditions

$$C < bf < C + t, \delta_I^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I > \frac{\alpha}{1 - \alpha}$$

the following is a pure strategy sequential equilibrium.

Beliefs: $\mu_G > 1/2, \mu_I > 1/2$

Strategies: $\varphi = 0, \eta = 1, \gamma = 0, \rho = 1, \sigma = 1$

Proof In this equilibrium the firm acts legally. The employee will file against a firm that has acted illegally but not against a firm that has acted legally. The judge condemns on a guilty signal and condemns on an innocent signal. This is an equilibrium where the system works correctly. Employees only file against firms that have acted illegally and the threat of this is enough to make acting legally a best response for the firm.

Firm: in this equilibrium the firm knows that if it acts illegally the employee will file and it will be condemned in court. Conversely, if the firm acts legally the employee will not file. The firm is therefore choosing between acting illegally, which gives $\Pi - F$ and legally, which gives 0. Since $\Pi < F$ the best response is to act legally.

Employee: the employee of an illegal firm is choosing between $bF - C$ and 0, as he knows that the firm will be condemned if he files the case. With the above conditions on the parameters filing is a best response.

The employee of a legal firm faces $bF - C - t$ and 0, as again he knows that the firm will be condemned in court and he will receive the reward. However, for the employee of a firm which has acted legally the sum of the filing costs and the fabrication costs is too high to make filing a best response; the decision not to file is the optimal strategy.

Judge: in this equilibrium the judge's information sets are off the equilibrium path so Bayes' rule is not very helpful. In order to test whether the equilibrium is sequential we adjust the pure strategies so that they contain errors. The addition of these errors means that the strategies are now completely mixed and there is therefore a strictly positive probability of reaching every node. Testing whether an equilibrium is sequential then involves testing that the strategies are best responses as these errors go to zero and hence the probability of reaching some nodes goes to zero.

For this potential equilibrium the pure strategies of the firm and the employee are $\varphi = 0, \eta = 1$ and $\gamma = 0$. The errors are incorporated by taking three sequences which converge to the pure strategies: $\varphi^n \xrightarrow{n \rightarrow \infty} 0$, $\eta^n \xrightarrow{n \rightarrow \infty} 1$, and $\gamma^n \xrightarrow{n \rightarrow \infty} 0$ respectively. The optimality of the judge's decision is then tested as $n \rightarrow \infty$ and these mixed strategies converge to their pure counterparts.

In order for a pure strategy of condemn to be optimal at the guilty signal information set μ_G^n has to converge to a number greater than one half.⁷ This is equivalent to the following condition:

$$\delta_G^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_G > \frac{1 - \alpha}{\alpha}$$

There is a similar equation for the judge's updated Bayesian beliefs when the signal is innocent. The condition at the innocent information set is:

$$\delta_I^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I > \frac{\alpha}{1 - \alpha}$$

From $\alpha > 1/2$ it follows that $\frac{\alpha}{1 - \alpha} > \frac{1 - \alpha}{\alpha}$. The tighter condition is therefore the one at the innocent signal information set. Fulfilling the innocent signal condition is a sufficient condition for fulfilling the guilty signal condition.

The beliefs in a sequential equilibrium only have to be consistent for one sequence of strictly mixed strategy profiles, sequential equilibrium places no restrictions on the set of sequences. As long as it is possible to find a set of sequences for which the above conditions hold we can claim that this is a sequential equilibrium. For instance, if we were to choose

$$\varphi^n = \frac{1}{n}, \eta^n = 1 - \frac{1}{n} \text{ and } \gamma^n = \frac{1}{n^2}$$

Then

$$\delta_I^n = \frac{\frac{1}{n} [1 - \frac{1}{n}]}{[1 - \frac{1}{n}] \frac{1}{n^2}} \xrightarrow{n \rightarrow \infty} \infty > \frac{\alpha}{1 - \alpha}$$

⁷ In order for a mixed strategy to be optimal, given a guilty signal, the condition has to hold with equality, i.e. $\mu_G > 1/2$. I deem this too restrictive an assumption on the sequences and I therefore ignore all equilibria with the judge playing a mixed strategy at her off the equilibrium path nodes. For the purposes of this paper they are called 'unreasonable beliefs'

So the condition holds.■

The other four pure strategy equilibria are described below.

Proposition 4 (Equilibrium Two, rewards too high equilibrium)

Under the parameter conditions:

$$bF > C + t$$

the following is a pure strategy sequential equilibrium.

$$\text{Beliefs: } \mu_G > \frac{1}{2}, \mu_I > \frac{1}{2}$$

$$\text{Strategies: } \varphi = 1, \eta = 1, \gamma = 1, \rho = 1, \sigma = 1$$

Proof As equilibrium one.■

Proposition 5 (Equilibrium Three, rewards too low equilibrium)

Under the parameter conditions:

$$C < bf, \delta_I^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I > \frac{\alpha}{1 - \alpha}$$

the following is a pure strategy sequential equilibrium.

$$\text{Beliefs: } \mu_G > \frac{1}{2}, \mu_I > \frac{1}{2}$$

$$\text{Strategies: } \varphi = 1, \eta = 0, \gamma = 0, \rho = 1, \sigma = 1$$

Proof As equilibrium one.■

Proposition 6 (Equilibrium Four, signal dependent, correct filing equilibrium)

Under the parameter conditions:

$$abF > C, \quad bF[1-\alpha] < C+t, \quad \alpha > \frac{\Pi}{F},$$

$$\delta_G^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_G > \frac{1-\alpha}{\alpha}, \quad \delta_I^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I < \frac{\alpha}{1-\alpha}$$

the following is a pure strategy sequential equilibrium.

$$\text{Beliefs: } \mu_G > \frac{1}{2}, \mu_I < \frac{1}{2}$$

$$\text{Strategies: } \varphi = 0, \eta = 1, \gamma = 0, \rho = 1, \sigma = 0$$

Proof As equilibrium one. ■

Proposition 7 (Equilibrium Five, signal dependent, no-one filing equilibrium)

Under the parameter conditions:

$$abF > C, \quad \delta_G^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_G > \frac{1-\alpha}{\alpha}, \quad \delta_I^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I < \frac{\alpha}{1-\alpha}$$

the following is a pure strategy sequential equilibrium.

$$\text{Beliefs: } \mu_G > \frac{1}{2}, \mu_I < \frac{1}{2}$$

$$\text{Strategies: } \varphi = 1, \eta = 0, \gamma = 0, \rho = 1, \sigma = 0$$

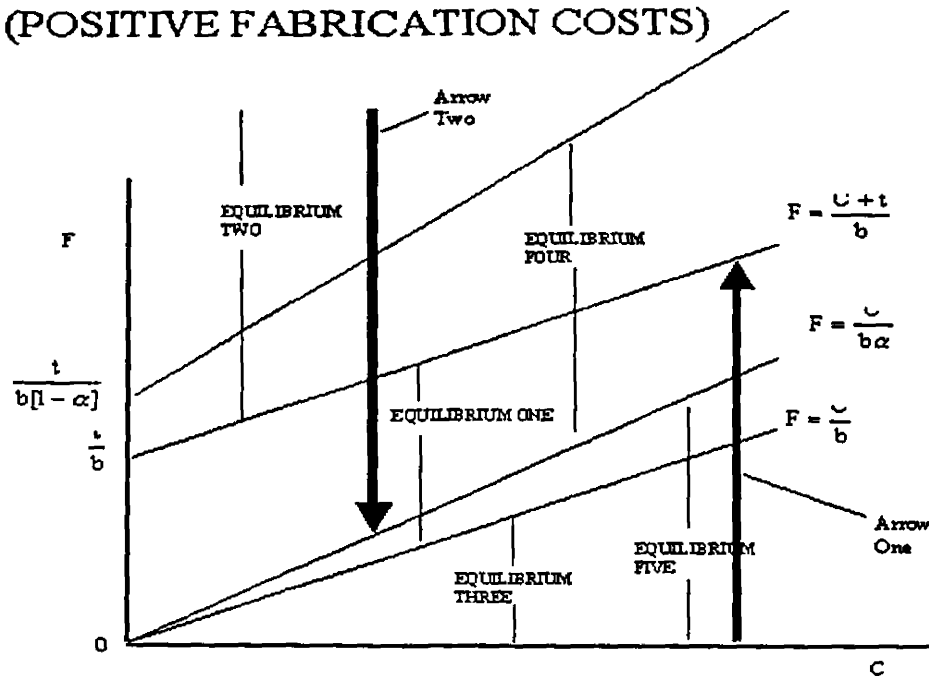
Proof As equilibrium one. ■

2.7. Discussion

I concentrate on the description of the five pure strategy equilibria described above.⁸

These five pure strategy equilibria are shown on the following diagram.

Figure Two
RESULTS WITH $t > 0$
(POSITIVE FABRICATION COSTS)



EQUILIBRIUM ONE: employee only files against firms which act illegally; judge condemns on both signals and firm acts legally.

EQUILIBRIUM TWO: employee files against firms which act illegally and legally; judge condemns on both signals and firm acts illegally.

EQUILIBRIUM THREE: employee never files; judge would condemn on both signals and firm acts illegally.

EQUILIBRIUM FOUR: employee only files against firms which act illegally; judge condemns on guilty signal and acquits on innocent signal; firm acts legally.

EQUILIBRIUM FIVE: employee never files; judge would condemn on guilty signal and acquit on an innocent signal; firm acts illegally.

$$F = \frac{C+t}{b}$$

ARROW ONE: up to the line $F = \frac{C}{b}$ the employee will not file if the firm acted legally.

$$F = \frac{C}{b\alpha}$$

ARROW TWO: above the line $F = \frac{C}{b\alpha}$ the employee will file if the firm acts illegally.

⁸ Some mixed equilibria with reasonable beliefs do exist. These can be split into two groups. The first set consists of those where $bF = C$, $bF = C+t$ or $abF = C$. In these cases the employee plays a mixed strategy and the results are a combination of the pure strategy equilibria. The other set involves the firm playing a precise mixed strategy and the judge playing a pure strategy on one signal and mixed on the other. All the equilibria in this third group can be located above the line $b = \frac{C+t}{F}$. I ignore these, as equilibrium two seems much more intuitive.

Equilibrium one (correct filing) is the band where the parameters fulfil $C < bF < C + t$. In this area, between the lines denoted $F = \frac{C+t}{b}$ and $F = \frac{C}{b}$ it is possible to eliminate corporate crime. Equilibrium one (correct filing) is the pure strategy separating equilibrium in this area. Here the firm knows that if it acts illegally the employee will file and this will lead to the firm being fined. Acting legally will give a payoff of zero, and since $F > \Pi$ acting legally is the best response.

For the employee of a firm which has acted illegally the choice is between $bF - C$ and 0. In this area of the diagram $bF > C$ so filing is the best response. For the parameter values in the equilibrium one area not filing is the best response for the employee of a firm which has acted legally as the *qui tam* payoff is not large enough to cover the costs of fabricating the evidence and filing the case. Note that the employee of a firm which acted legally knows that the firm will be condemned, it is not fear of the firm being acquitted that stops him from filing, he does not file because the reward is too small.

The judge's decision nodes are off the equilibrium path, but the conditions required for the judge to condemn at both information sets are still $\mu_G > \frac{1}{2}$ and $\mu_I > \frac{1}{2}$. Loosely speaking this can be thought of as a condition on the probability of strategy errors and in this equilibrium the condition is that the firm is more likely to play illegal by mistake than the employee of a legal firm is to file by mistake.⁹

If the rewards are too high then the equilibrium strategy of the employee is to file, regardless of the firm's strategy. The rewards for filing are such that it is optimal for the employee to fabricate the evidence and take firms to court even when they are acting legally. In this equilibrium, equilibrium two (rewards too high), the firm is choosing between a payoff of $\Pi - F$ and $-F$. Whatever it does the firm will be taken to court and condemned so the optimal strategy is to act illegally, as by doing this the firm at least gains the extra illegal profits Π . Equilibrium two is a pooling equilibrium, as the employee performs the same action whether the firm acted legally or illegally. The judge's best response in this equilibrium is to play a pure strategy of condemn at both information sets as she knows that the firm's optimal strategy is to act illegally.

⁹ The judge's off the equilibrium path beliefs are discussed in detail later in the paper.

If rewards are too low then the optimal strategy of the employee is never to file a *qui tam* case, even if the firm has acted illegally. If the employee never files it is optimal for the firm to act illegally, as it knows it will never be taken to court. Equilibrium three (rewards too low) is a pure strategy equilibrium in this area. Again this is a pooling equilibrium as the employee takes the same action in equilibrium, regardless of whether the firm acted legally or illegally. As before the judge condemns at both information sets.

The other two pure strategy equilibria depend more explicitly on the value of α , i.e. α enters into more than the sequence conditions. Exactly placing equilibria four (signal dependent, correct filing) and five (signal dependent, no-one filing) on Figure Two is not possible. In the figure the lines representing the boundaries of equilibria four and five $F = \frac{C}{b\alpha}$ and $F = \frac{C+t}{b[1-\alpha]}$ are drawn for a specific chosen value of α .

In equilibrium four we have the pure strategy equilibrium that one may have hoped for.¹⁰ In this case the judge condemns on a guilty signal and acquits on an innocent signal. The employee will file a case if the firm acted illegally and will not file if the firm acted legally. If the firm acts illegally it knows that it will be condemned in court with a probability α and this is high enough to make acting legally the firm's best response.

What is interesting about equilibrium four (signal dependent, correct filing) is that the judge's information sets are not reached but the judge plays different strategies at each information set. This gives an opportunity to discuss in more depth the beliefs of the judge when her decision nodes are off the equilibrium path.

¹⁰ The drawing of equilibrium four in Figure Two includes the additional implicit assumption that $\alpha > \Pi/F$. Triple damages and the fact that $\alpha > 1/2$ makes this a relatively easy assumption to fulfil. If $\alpha < \Pi/F$ then equilibrium four no longer exists.

Figure Three

The effect of α on the probability boundaries.

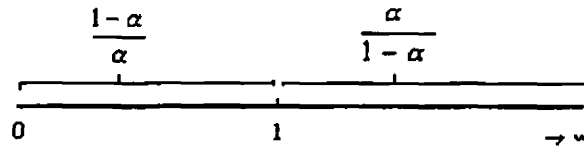


Figure Three above shows the two parameter conditions that have to be fulfilled by the sequences when we are dealing with off the equilibrium path beliefs. The scale goes from zero on the left to infinity on the right. The right hand condition is $\frac{\alpha}{1-\alpha}$. Since $\frac{1}{2} < \alpha < 1$ this implies that $1 < \frac{\alpha}{1-\alpha} < \infty$, furthermore, the derivative is $\frac{dF(\alpha)}{d\alpha} = \frac{1}{\alpha^2} > 0$. These two facts imply that as α goes from $\frac{1}{2}$ to one, $\frac{\alpha}{1-\alpha}$ goes from one to infinity.

The second parameter condition, which floats in the area between zero and one, is $\frac{1-\alpha}{\alpha}$. It is restricted to be between zero and one because α is restricted to be between $\frac{1}{2}$ and one. This time the derivative is $\frac{dF(\alpha)}{d\alpha} = \frac{-1}{\alpha^2} < 0$, so as α increases the value of this function decreases.

The optimal strategies of the judge depend on where the sequences converge to. In this equilibrium, equilibrium four, in order for convicting on a guilty signal to be a best response the following condition, which is derived from $\mu_G > \frac{1}{2}$, has to be satisfied:

$$\delta_G^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_G > \frac{1-\alpha}{\alpha}$$

The three sequences converge, for this equilibrium, as follows: $\varphi^n \xrightarrow{n \rightarrow \infty} 0$, $\eta^n \xrightarrow{n \rightarrow \infty} 1$, and $\gamma^n \xrightarrow{n \rightarrow \infty} 0$. Relating this to Figure Three, what this condition says is that the convergence point of this sequence has to be a value to the right of $\frac{1-\alpha}{\alpha}$.

At the innocent signal information set the judge acquits the firm. The restriction that $\mu_i < 1/2$ furnishes

$$\delta_i^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_i < \frac{\alpha}{1 - \alpha}$$

This implies that the convergence point of the sequence has to be to the left of $\frac{\alpha}{1 - \alpha}$. Since

$\frac{\alpha}{1 - \alpha} > \frac{1 - \alpha}{\alpha}$ it is possible to find sequences that fit this condition. If we were to chose

$$\varphi^n = \frac{1}{n}, \eta^n = 1 - \frac{1}{n} \text{ and } \gamma^n = \frac{1}{n}$$

Then

$$\delta_i^n = \frac{\frac{1}{n} [1 - \frac{1}{n}]}{[1 - \frac{1}{n}] \frac{1}{n}} = 1 \text{ and } \frac{1 - \alpha}{\alpha} < 1 < \frac{\alpha}{1 - \alpha}$$

How much faith we are willing to put in this sequential equilibrium depends on the size of the space between these two conditions, the larger the space the more faith one should have in this equilibrium. More intuitively, if the signal given by the court system is almost perfect then the judge will follow the signal and acquit on an innocent signal and condemn on a guilty signal. Note that as α increases the lower bound $\left(\frac{1 - \alpha}{\alpha}\right)$ decreases, making it easier to fulfil, simultaneously as α increases the upper bound $\left(\frac{\alpha}{1 - \alpha}\right)$ heads to infinity, making it too easier to fulfil.

The conditions for this equilibrium can be compared to the conditions for equilibrium one (correct filing). The conditions on the *qui tam* payment in equilibrium one are $C < bF < C + t$. In equilibrium four the payment conditions are $\alpha bF > C$ and $[1 - \alpha]bF < C + t$. Figure Two shows that there is some overlap here and there are some parameter values when the reward conditions for equilibria one and four will be fulfilled simultaneously. The difference to contemplate is therefore the difference in the beliefs of the judge. In equilibrium one the judge condemns on both signals, in four she condemns on a

guilty signal and acquits on an innocent signal. For the judge to condemn and acquit on both an innocent and a guilty signal the sufficient and necessary condition is:

$$\delta_I^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I > \frac{\alpha}{1 - \alpha}$$

On Figure Three this is represented by the values between $\frac{\alpha}{1 - \alpha}$ and infinity. Whether one thinks that equilibrium one or four is more plausible depends on the value assigned to α . If α is large then the gap between $\frac{\alpha}{1 - \alpha}$ and $\frac{1 - \alpha}{\alpha}$ will be large and it seems more plausible to say that equilibrium four is the one to concentrate on. Furthermore, as α approaches one it also become easier to fulfil the conditions $\alpha b F > C$ and $[1 - \alpha] < C + t$. Non-technically, as α increases the expected payoff from filing against illegal firms increases but the expected payoff from filing against legal firms decreases. It is thus more likely that the result will be a separating equilibrium where only the employee of the illegal firm will file a case.

As was shown earlier the limit case of this is when $\alpha = 1$. This is when the signal given by the evidence in court is perfectly informative and the judge always acquits on an innocent signal and always condemns on a guilty signal. In this case equilibrium one disappears as it impossible to find sequences which converge to a value which is strictly greater than infinity. Simultaneously the gap between $\frac{\alpha}{1 - \alpha}$ and $\frac{1 - \alpha}{\alpha}$ becomes the gap between infinity and zero and it is impossible, given that $\eta \in [0, 1]$, $\gamma \in [0, 1]$ and $\varphi \in [0, 1]$ to find a sequence which converges to a point outside this range. The only beliefs which fulfil the conditions imposed by sequential equilibrium are $\mu_G > 1/2$ and $\mu_I < 1/2$. So the judge's optimal strategies are $\rho = 1$ and $\sigma = 0$: condemn on a guilty signal and acquit on an innocent signal.

The actions of the judge in the last pure strategy equilibrium, equilibrium five (signal dependent, no-one filing), also involve the judge acquitting on an innocent signal and condemning on a guilty signal. In this respect it is like equilibrium four, but the payoff conditions are similar to equilibrium three (rewards too low) as the rewards to filing are not high enough to entice the employee to file. However, when discussing the beliefs in equilibria four (signal dependent, correct filing) and five one has to be careful about the sequence conditions. It is not possible to make a direct comparison between equilibria five

and four, as the limit points of the individual sequences are different. In equilibrium four the sequences must converge as follows:

$$\varphi^n \xrightarrow{n \rightarrow \infty} 0, \eta^n \xrightarrow{n \rightarrow \infty} 1 \text{ and } \gamma^n \xrightarrow{n \rightarrow \infty} 0$$

Where as in equilibrium five the sequences are as follows:

$$\varphi^n \xrightarrow{n \rightarrow \infty} 1, \eta^n \xrightarrow{n \rightarrow \infty} 0 \text{ and } \gamma^n \xrightarrow{n \rightarrow \infty} 1$$

The difference here is in the strategies of the firm and the employee of a firm that has acted illegally. In equilibrium four (signal dependent, correct filing) the employee will file if the firm acts illegally, while this is not the case in equilibrium five where the rewards are too low. It is therefore not possible to directly compare the off the equilibrium path beliefs because, as was stated before, the convergence points of the individual sequences are different. It is therefore impossible to claim that one is more realistic than the other.

Two equilibria which are comparable in this respect are equilibria three (rewards too low) and five (signal dependent, no-one filing). Both of these have the same pure strategies of the employee and the firm. Their only difference is in the beliefs of the judge. In equilibrium three the judge condemns on both signals and in equilibrium five she condemns on a guilty signal and acquits on an innocent signal. Like before which of these is more plausible depends on the value of α . As α increases equilibrium five becomes more plausible as one has to put more and more restrictions on the sequences to get a result that fulfils

$$\delta_I^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I > \frac{\alpha}{1 - \alpha}$$

In other words, it becomes less realistic that the judge will condemn on an innocent signal, as she does in equilibrium three.

2.7.1. Employee Best Responses

With multiple equilibria it is not always clear what the best response of the employee will be, as for some parameter conditions the employee's best responses differ according to the equilibrium chosen. More encouragingly, for some parameter conditions the employee's best

response is independent of the equilibria. In these cases we can make definite predictions about the efficacy of the *qui tam* system.

An area where we can easily predict the strategies is below the line $F = \frac{C}{b}$ in Figure Two.

When the parameters take on these values the rewards are too low and the employee never files a case. This is true for both equilibrium three and equilibrium five.

Between the lines $F = \frac{C}{b}$ and $F = \frac{C}{b\alpha}$ there is some indeterminacy and we cannot make clear predictions about the best responses of the employee. In equilibrium one the employee only files against firms that acted illegally. This is not the case in equilibrium five where the employee never files, irrespective of whether the firm acted legally or illegally. Therefore one cannot predict all the best responses of the employee, one can only predict that the employee will not file against companies that have acted legally.

In the area between $F = \frac{C}{b\alpha}$ and $F = \frac{C+t}{b}$ the employee's best responses are indifferent to the choice of the equilibrium. In equilibria one and four the employee will only file against those firms that acted illegally. One can therefore predict that the system will work correctly and firms will act legally due to the credible threat of being taken to court if they act illegally.

Another important factor to note is that the position of the line $F = \frac{C}{b\alpha}$ is dependant on the value of α . As α approaches one the gradient of the line $F = \frac{C}{b\alpha}$ decreases $\left(\frac{d^2F}{dC d\alpha} = \frac{-1}{b\alpha^2}\right)$, and it rotates towards the line $F = \frac{C}{b}$. Thus as α increases the size of the indeterminate area, the area between $F = \frac{C}{b}$ and $F = \frac{C}{b\alpha}$, decreases. Simultaneously, the determinate area between $F = \frac{C}{b\alpha}$ and $F = \frac{C+t}{b}$ increases. The combined effect is that an increasing α allows one to be more confident about the prediction of best responses.

Between $F = \frac{C+t}{b}$, and $F = \frac{C+t}{b[1-\alpha]}$ there is again some indeterminacy. The best response in equilibrium four is for the employee not to file against firms that have acted legally while in

equilibrium two the best response is to file a case whether the firm acted legally or illegally. The only thing one can predict here is that the employee will file cases against firms that have acted illegally.

Above the line $F = \frac{C+t}{b[1-\alpha]}$ the employee always files. In this case one can be absolutely certain that if rewards are set too high then the worst outcome will result: employees will file against legal and illegal firms and thus the optimal strategy of firms is to always act illegally.

Similar to before, however, the line $F = \frac{C+t}{b[1-\alpha]}$ is dependent on the α variable. As α increases the intercept with the y-axis increases in value, in addition to this the gradient of the line increases $\left(\frac{d^2F}{dC d\alpha} = \frac{1}{b[1-\alpha]^2} > 0\right)$. The combined movement is therefore an anti-clockwise rotation around a rising fulcrum. The area above $F = \frac{C+t}{b[1-\alpha]}$ therefore decreases as α increases and the area that implies firms always acting illegally decreases.

The above discussion is summarised by the two arrows on Figure Two. Up to the line $F = \frac{C+t}{b}$, represented by Arrow One, the employee will not file against legal firms. Above the line $F = \frac{C}{b\alpha}$, represented by Arrow Two, the employee will file against illegal firms. For a *qui tam* system to be successful to the reward structure has to be set so that it is optimal to file against illegal companies and a best response not to file against legal companies.

The stark nature of the results is driven by the use of relators. In standard law enforcement it is a government appointed official that decides which individuals should be taken to court and the utility function of these prosecutors is usually taken to be the maximisation of social welfare. There is therefore little incentive for these authorities to take firms acting legally to court. Their limited resources would be better spent on the firms that have acted illegally. Furthermore, since these authorities do not normally directly receive the fines there is little incentive to prosecute firms that are likely to be acquitted.¹¹ The result of this, and it holds

¹¹ In the US any fines are given to charity foundations such as the witness protection programme. In the EU the fines imposed by the European Court of Justice and DGIV do not go to the specific budget of DGIV, but are added to the central EU budget.

for most transgressions of the law, is that the probability of an innocent party appearing in court is very small; much lower than the probability of a guilty person appearing in court. Given this the joint probability of an innocent person being found guilty, as defined below, is very small.

$\text{Prob}(\text{convicted} \ \& \ \text{appear in court} \ \& \ \text{acted legally}) =$

$\text{Prob}(\text{convicted} \mid \text{appear in court} \ \& \ \text{acted legally}) \times$

$\text{Prob}(\text{appear in court} \mid \text{acted legally}) \times \text{Prob}(\text{acted legally})$

The probability on the left hand side is the probability of a Type One error, the wrongful conviction of an innocent person. This is low in the standard models of enforcement as $\text{Prob}(\text{appear in court} \mid \text{acted legally})$ is very small (in most economic models this probability is assumed to be zero).

The problem with the use of relators is that they have to be given a personal stake in the claim in order to entice them to come forward and file cases. If the rewards are set too high then they will begin to take firms that acted legally to court unless the legal system is almost perfect and the judge nearly always acquits firms that acted legally. This personal stake of the relator significantly increases $\text{Prob}(\text{appear in court} \mid \text{acted legally})$. As a result of this the overall probability of Type One errors can increase drastically. This result has also been discussed in the literature. Landes & Posner (1975) note that when law is enforced privately the enforcers no longer care whether they are prosecuting innocent or guilty defendants. Their utility is derived only from fine income so there is a serious risk of over enforcement.

If the court system is not perfect and rewards are very large, provoking many suits, the probability of appearing in court given that the firm acted legally will be insignificantly different from the probability of appearing in court given that the firm acted illegally. The critical factors are therefore $\text{Prob}(\text{convicted} \mid \text{appear in court and acted legally})$ and $\text{Prob}(\text{convicted} \mid \text{appear in court and acted illegally})$. If these two probabilities are similar (implying that judges have difficulty distinguishing those who really acted illegally) then the two conviction probabilities will be similar. There is therefore little advantage in acting legally as the incentive to act legally relies on two factors:

1. Breaking the law leads to punishment
2. Not breaking the law leads to no punishment.

The problem with the incorrect use of relators is that the probability of being punished even though one acted legally can be too high. If it reaches this critical level then firms break the law in order to at least gain the benefit of acting illegally.

2.8. Model if With No Fabrication Costs ($t = 0$)

We now move to the case where we eliminate t and see how this affects the model. The elimination of t means that there is no cost difference between preparing and trying a real case, where the firm played illegal, and trying a fabricated case when the firm acted legally. This situation would be a better representation of reality if the cost of fabricating the evidence of illegalities was a very small (negligible) proportion of the costs of trying the case. This is probably not true for cases involving bid-rigging agreements, where the fabrication of evidence of meetings and agreements is likely to be difficult, especially as the employee will have to provide evidence about the other firms in the alleged agreement. Where t could be close to zero, or even zero, is in cases where some fraud has already occurred and the employee is trying to make the fraud look even bigger. This may occur when one individual is in charge of preparing and checking all the documentation relating to the invoices sent to the government. For this person adjusting the internal and external documentation so that extra discrepancies appear, giving the appearance of a larger fraud, will be relatively costless. At least in terms of the effort involved.

Like in the model with $t > 0$ I concentrate on the pure strategy equilibria A, B, C and D.¹²

Proposition 8 (Equilibrium A)

Under the parameter conditions:

¹² Some mixed equilibria with reasonable beliefs do exist when $t = 0$. These can be split into two groups. The first set consists of those where $bF = C$ or $\alpha bF = C$. In this case the employee plays a mixed strategy and the results are a combination of the pure strategy equilibria. The other set involves the firm playing a precise mixed strategy and the judge playing a pure strategy at one signal and mixed at the other. All the equilibria in this third group can be

$$bF > C$$

the following is a pure strategy sequential equilibrium.

$$\text{Beliefs: } \mu_G > \frac{1}{2}, \mu_I > \frac{1}{2}$$

$$\text{Strategies: } \varphi = 1, \eta = 1, \gamma = 1, \rho = 1, \sigma = 1$$

Proof As equilibrium one. ■

Proposition 9 (Equilibrium B)

Under the parameter conditions:

$$bF < C$$

the following is a pure strategy sequential equilibrium.

$$\text{Beliefs: } \mu_G > \frac{1}{2}, \mu_I > \frac{1}{2}$$

$$\text{Strategies: } \varphi = 1, \eta = 0, \gamma = 0, \rho = 1, \sigma = 1$$

Proof As equilibrium one. ■

Proposition 10 (Equilibrium C)

Under the parameter conditions:

$$abF > C, \quad bF[1-\alpha] < C, \alpha > \frac{\Pi}{F},$$

$$\delta_G^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_G > \frac{1-\alpha}{\alpha}, \quad \delta_I^n = \frac{\varphi^n \eta^n}{[1-\varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I < \frac{\alpha}{1-\alpha}$$

the following is a pure strategy sequential equilibrium.

located above the line $b = C/F$. I ignore these as equilibrium A seems much more intuitive for these parameter

Beliefs: $\mu_G > 1/2, \mu_I < 1/2$

Strategies: $\varphi = 0, \eta = 1, \gamma = 0, \rho = 1, \sigma = 0$

Proof As equilibrium one. ■

Proposition 11 (Equilibrium D)

Under the parameter conditions:

$$\alpha b F < C,$$

$$\delta_G^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_G > \frac{1 - \alpha}{\alpha}, \quad \delta_I^n = \frac{\varphi^n \eta^n}{[1 - \varphi^n] \gamma^n} \xrightarrow{n \rightarrow \infty} \delta_I < \frac{\alpha}{1 - \alpha}$$

the following is a pure strategy sequential equilibrium.

Beliefs: $\mu_G > 1/2, \mu_I < 1/2$

Strategies: $\varphi = 1, \eta = 0, \gamma = 0, \rho = 1, \sigma = 0$

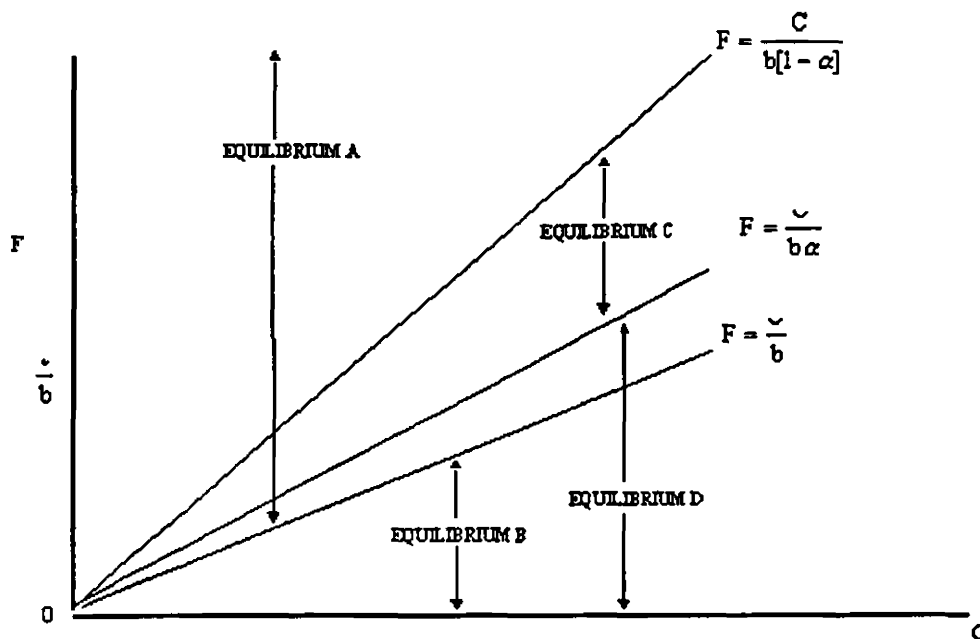
Proof As equilibrium one. ■

2.9. Discussion

The figure below shows the pure strategy equilibria when the fabrication costs are zero.

conditions.

Figure Four
RESULTS WITH $t=0$
(ZERO FABRICATION COSTS)



EQUILIBRIUM A: employee files against firms which act illegally and those which act legally; judge condemns on both signals; and firm acts illegally.
 EQUILIBRIUM B: employee never files; judge would condemn on both signals; and firm acts illegally.
 EQUILIBRIUM C: employee only files against firms which act illegally; judge would condemn on guilty signal and acquit on an innocent signal both signals; and firm acts legally.
 EQUILIBRIUM D: employee never files; judge condemns on guilty signal and acquits on innocent signal; and firm acts illegally.

In equilibrium A, which has the same beliefs and strategies as equilibrium two, the firm's best response is to choose the pure strategy of illegal to obtain the benefit of the crime. This is the less standard, but equally valid argument for why people commit crime: the judge will condemn them so they might as well take the benefit of acting illegally if they are going to be fined anyway. This argument is particularly relevant for ex-offenders and probably the real reason behind the innocent until proven guilty maxim. Previous offenders should be treated equally in order to encourage them to re-integrate into society and they should not feel that they will always be stigmatised by their previous convictions.

In equilibrium B, which has the same beliefs and strategies as equilibrium 3, the firm acts illegally because it knows that the rewards to the employee are too small to entice him to file. With no-one filing the optimal strategy is to act illegally. This is the standard argument for breaking the law. Individuals break the law because the expected value of the fine is too low to deter them from acting this way.

In equilibrium C, which has the same beliefs and strategies as equilibrium four, we obtain the only pure strategy equilibrium where the firm does not act illegally.¹³ This equilibrium relies on α , the efficacy of the court system at signalling guilt and innocence, being close to one for five reasons.

1. α needs to be large to make it an optimal strategy for the firm not to act illegally. With α close to one the firm is likely to be fined if it acts illegally so the best response is to act legally.
2. α needs to be large to make it an optimal strategy for the employee to file when the firm acted illegally. With α close to one the signal is likely to be guilty so the employee is likely to receive a reward.
3. α needs to be large to make it an optimal strategy for the employee not to file when the firm acted legally. With α close to one the signal is likely to be innocent so the employee is not likely to receive a reward.

¹³ The drawing of equilibrium C in Figure Four, like equilibrium four in Figure Two, also requires the additional assumption that $\alpha = \Pi/F$.

4. α needs to be large to make it a reasonable strategy for the judge to condemn the firm on a guilty signal. With α close to one the sequence condition for a guilty signal is easier to fulfil, as $\frac{1-\alpha}{\alpha}$ becomes smaller as α increases.
5. α needs to be large to make it a reasonable strategy for the judge to acquit the firm on an innocent signal. With α to one the sequence condition for an innocent signal is easier to fulfil. As α increases $\frac{\alpha}{1-\alpha}$ increases, making it easier to find sequences that converge to a value below $\frac{\alpha}{1-\alpha}$.

Equilibrium D has the same best response strategies as equilibrium five in the model with $t > 0$. Again the judge condemns on a guilty signal and acquits on an innocent signal. However, the low rewards make not filing an optimal response in both cases. This means that the firm's optimal choice is acting illegally.

2.9.1. Employee Best Responses

In common with Figure Two, it is sometimes not clear what the best responses of the employee will be under certain parameter conditions.

Below the line $F = \frac{C}{b}$ the best responses are easy to predict: the employee never files a case.

This is true for equilibria B and D.

Between the lines $F = \frac{C}{b}$ and $F = \frac{C}{b\alpha}$ there is complete indeterminacy. In equilibrium A the employee files against all firms where as in D he never files. No predictions are therefore possible.

In the space between $F = \frac{C}{b\alpha}$ and $F = \frac{C}{b[1-\alpha]}$ the only prediction possible is that the employee will file against firms which have acted illegally. This is because in equilibrium A the employee always files and in C the employee files only if the firm acted illegally.

Above the line $F = \frac{C}{b[1-\alpha]}$ determinacy is obvious as only one equilibrium is possible. In equilibrium A the employee files against both types.

As before the positions of the lines $F = \frac{C}{b[1-\alpha]}$ and $F = \frac{C}{b\alpha}$ depend on α . As α increases the area of indeterminacy increases, as $F = \frac{C}{b\alpha}$ rotates clockwise towards $F = \frac{C}{b}$ and $F = \frac{C}{b[1-\alpha]}$ rotates anti-clockwise. This increasing α has an unwelcome effect on the predictions but a positive effect from a normative point of view. In the model the increasing α makes prediction of the employee's best responses more difficult as it increases the overlap between equilibrium A and equilibrium C. From a normative point of view the α increase is good because it increases the area of A, which is the only equilibrium where employees file against firms which have acted illegally and not against firms which have acted legally.

2.10. Conclusion

The general conclusion of this paper is that the introduction of a *qui tam* system is no foolproof panacea for the detection and prosecution of corporate crime. Within this general result four specific points should be mentioned.

1. The efficacy of the court system, how good it is at signalling guilt and innocence is critical to the success of the system. In the special case where the signal given by the court system is perfectly informative about whether the firm acted legally or illegally (illegality is verifiable information) it is possible and optimal to eliminate completely corporate crime.
2. When the signal given by the court system is not perfectly informative no definite advice can be given. If the court system almost perfectly signals the guilt and innocence of the firm then the introduction of the system is probably warranted. In other words, when the evidence presented in court gives a clear signal about whether the firm acted illegally or legally one can be confident that only the employees of illegally acting firms will file cases. If it is difficult, from the evidence presented in court, to tell whether the firm acted illegally or legally then one should be very wary about introducing *qui tam* legislation. The potential rewards may entice

individuals to invent cases, especially if there is a high probability of judicial error. This increased potential for type one errors, relative to systems involving an independent prosecution service, means that *qui tam* systems are only useful when it is easy to distinguish between those firms that acted legally and those that acted illegally.

3. If there is no difference in the costs of filing a real and a fabricated case then one should be very wary about introducing a *qui tam* system. In the False Claims Act the extra expected cost of fabricating a case has two main components: first, the effort involved in fabricating rather than collecting the evidence; and second, the increased chances of having to pay the legal fees of the acquitted firm under the Act's fee shifting arrangements. The larger are the expected costs the more faith one should have in a *qui tam* system. As was stated before, *qui tam* systems lend themselves more to corporate crimes where the evidence is harder to fabricate such as bid-rigging cases, since the invention of a bid-rigging offence would involve fabrication of evidence about the actions of a number of firms.
4. The model also demonstrates the risk posed by excessively high rewards. Too high rewards will encourage employees to file cases against firms that have acted legally. If they are successful with these claims then the end result may be firms committing more crime, as if firms believe they will be prosecuted whether they act legally or illegally it is optimal to act illegally in order to gain the benefit of the crime. Especially worrying is the latest news on payoffs. Four years after filing her federal False Claims Act suit Mrs Knoob, who worked at Blue Cross Blue Shield of Illinois, has now received the final instalment of her relator payoff of \$29,108,999.¹⁴ With payoffs are large as these there is a serious risk of employees filing against innocent firms.

¹⁴ Source: <http://www.igc.org/cna/news/cnn12799.html>. Blue Cross whistle-blowers reap \$29 million. Consulted 15/10/00.

3. OUTSIDER TRADING AND ANTITRUST ABUSES

3.1. Introduction

Imagine the following example of outsider trading:

Company X is about to publicise the launch of a new product. This new product is vastly superior to the products of its competitors and therefore likely to significantly reduce their profits. Before the publicising of the product Company X takes short positions in the shares of its competitors through a combination of puts and short selling. When the product is publicised the share prices of the other competitors fall. Company X closes its position and pockets the profits.

Presently, it would appear that this type of activity is illegal in the EU but legal in the US. In this paper I discuss the strategic value of these outsider trading opportunities. The results show that the role of these outsider trading opportunities is similar to the role of capacity investment in Dixit (1980). First, outsider trading can be used to make threats credible and, second, outsider trading moves the reaction function of the trading firm. Dixit (1980) studies entry deterrence; here I study predation and cartel stability.

In the predation model I study how the ability of a predator to take a short position in the shares of the target firm can lead to the predator overcoming the standard commitment problem. The predator's gain from the fall in the share price makes the predator's threats credible and rational. Under certain conditions the equilibrium results in the target firm exiting the market as soon as it learns of the predation strategy. However, the results are heavily affected by the choice of whether the products are strategic substitutes or strategic complements.

The second half of the paper deals with the stability of cartels when cartel members are allowed to take short positions in the shares of their competitors. The results show that the ability to take short positions in competitors make cartels less stable.

The only previous paper that studies the strategic effects of short positions is Hansen and Lott (1995). They study the effect that short positions have on an entry deterrence game. The strategic effects of long positions however, have been more extensively studied.

The effect of taking long positions, in the specific form of cross equity holdings, was studied by Reynolds and Snapp (1986). They show that increasing partial equity interests lead to smaller output levels and higher prices in Cournot equilibria. Malueg (1992) studies the effects of cross equity holdings on the incentives for remaining in a cartel and shows that breaking the cartel may lead to reduction in profits because (amongst other reasons) the value of the profits obtained from the other firms will decrease if the cartel breaks. Malueg (1992) differs from the study of cartels presented here in two main respects. First, in this paper I deal with short positions and long positions whereas Malueg (1992) studies only long positions. Second, the non-product market profits that result from breaking the cartel come from transactions in the financial assets markets, rather than through partial equity interests. The profits in the model studied here come from exploiting information asymmetries.

The rest of the paper is laid out as follows. Section 2 discusses the murky legal environment surrounding insider and outsider trading in the EU and the US. Section 3 delivers the model of predation and outsider trading, assuming that the products are strategic substitutes. Section 4 analyses the effect of outsider trading on the stability of cartels. The conclusions are in Section 5. Appendix one contains the results for a predation model where the products are strategic complements.

3.2. Legality

In this section I discuss the legality of outsider trading in the EU and the US. In the EU outsider trading, like insider trading, seems to be illegal. However, in the US the situation is less clear and the definitions of insider trading are almost continually being adjusted by the Circuit Courts and the Supreme Court. However, a reading of the current state of the law would seem to suggest that outsider trading is legal in the US. For the purposes of this paper I define the difference between insider and outsider trading to be the following: outsider trading is trading based on information that comes from outside the firm, while insider trading is based on information that comes from inside the firm.

3.2.1. European Union

At the EU level there is no legislation that deals specifically with outsider trading. The question we must therefore address is whether the legislation on insider trading covers outsider trading. Fortunately, there is a European Council Directive that attempts to coordinate national legislation on insider trading. Since all the national legislations should confirm to this directive it is possible to make generalisations about insider trading laws across Europe. The national legislations are influenced by the European Council Directive of 13 November 1989 (89/592/EEC). This directive lays down guidelines for the harmonisation of insider trading. The directive defines insider information as the following:

“‘inside information’ shall mean information which has not been made public of a precise nature relating to one or several issuers of transferable securities, which, if it were made public would be likely to have a significant effect on the price of the transferable securities in question;” (Art. 1.1).

Note that this definition has two parts. The first part deals with ‘information which has not been made public of a precise nature’. It does not make any statements about where this information comes from. This is very important for the discussion of insider and outsider trading. Insider information comes from within the firm; outsider information from outside the firm. The text here makes no distinction as to the source of the information. Therefore, it would seem that outside information is a subset of the ‘inside information’ defined above, and whether it originated in the competitor firm or in the trading firm is irrelevant.

The second part deals with whether the information ‘if it were made public would be likely to have a significant effect on the price’. The information that one firm is about to attempt to force another to exit through the use of a predation strategy, or that it is about to break from a cartel, is undoubtedly a piece of information which would have ‘a significant effect on the price of the transferable securities in question’.

It would appear that outsider trading is covered by Article 1. The next step is analyse whether making use of this for personal gain is illegal. This is covered by Article 2, which states:

"Each Member State shall prohibit any person¹ who:

- by virtue of his membership of the administrative, management, or supervisory bodies of the issuer,
- by virtue of his holding in the capital of the issuer, or
- because he has access to such information by virtue of the exercise of his employment, profession, or duties, possesses inside information from taking advantage of that information with full knowledge of the facts by acquiring or disposing of for his own personal account, or for the account of a third party, either directly or indirectly, transferable securities of the issuer or issuers to which that information relates."

Due to the specifics of the legal question here we have to analyse the decision at the individual level, rather than the firm level. It is clear that the person in the trading firm acquired the information through 'the exercise of his employment, profession, or duties' and is taking advantage of the information by trading on behalf of the third party, which is in this case the trading firm. One can therefore be fairly confident in concluding that outsider trading should be illegal in all the EU states that have enacted this Directive into their national legislation.

The Directive was adopted into English and Welsh law in the Criminal Justice Act of 1993. The offence is laid out in Section 52:

"(1) An individual who has information as an insider is guilty of insider dealing if, in the circumstances mentioned in subsection (3), he deals in securities that are price affected securities in relation to the information...

¹ Article 2.2 covers the case of where the person is a firm and states:

"Where the person referred to in paragraph 1 is a company or other type of legal person, the prohibition laid down in that paragraph shall apply to the natural persons who take part in the decision to carry out the transaction for the account of the legal person concerned."

(3) The circumstances referred to above are that the acquisition or disposal in question occurs on a regulated market, or that the person dealing relies on a professional intermediary or is himself acting as a professional intermediary."

The rest of the Act then continues with the definitions of the above words. The most logical conclusion is that outsider trading is illegal in England and Wales.

3.2.2. United States

In contrast to the situation in the European Union, in the US outsider trading would seem to be legal under certain conditions. Insider trading has never been precisely defined by the US Congress. Instead, the Securities and Exchange Commission (SEC) was left to control insider trading by using two broad antifraud provisions in the Securities and Exchange Act of 1934: § 10(b)² and Rule 10b-5³. The SEC gradually widened the scope of these provisions, and by the 1970s the general view was that anyone holding material, non-public information was subject to a 'disclose or abstain rule'. The Supreme Court then sharply curtailed liability in *Chiarella v. United States*, 445 U.S. 222 (1980) and *Dirks v. Securities and Exchange Commission*, 103 S. Ct. 3255 (1983). Here the Court stated that there was no general duty to abstain from trading when in possession of material, non-public information and developed the fiduciary duty theory of liability. A sister theory, the misappropriation theory, was validated in *United*

² The relevant parts of §10 state:

"It shall be unlawful for any person, directly or indirectly, by the use of any means or instrumentality of interstate commerce or of the mails, or of any facility of any national securities exchange-

(b) To use or employ, in connection with the purchase or sale of any security registered on a national securities exchange or any security not so registered, any manipulative or deceptive device or contrivance in contravention of such rules and regulations as the Commission may prescribe as necessary or appropriate in the public interest or for the protection of investors."

³ Rule 10b-5 states:

"It shall be unlawful for any person, directly or indirectly, by the use of any means or instrumentality of interstate commerce, or of the mails or of any facility of any national securities exchange,

a. To employ any device, scheme, or artifice to defraud

b. To make any untrue statement of a material fact or to omit to state a material fact necessary in order to make the statements made, in the light of the circumstances under which they were made, not misleading, or

c. To engage in any act, practice, or course of business which operates or would operate as a fraud or deceit upon any person, in connection with the purchase or sale of any security."

States v. O'Hagan, 117 S. Ct. 2199 (1997). These two theories, and their effect on outsider trading are discussed below.

The fiduciary duty doctrine is based on a trust relationship between individuals. For example, the employees of a firm are deemed to have a fiduciary duty to the shareholders of that firm. Any insider in that firm who trades on non-public information is deemed to have violated that duty. The subsequent case law expanded the definition of insider and developed a derivative fiduciary duty to catch those tippees⁴ who received information from insiders. With reference to the specific issue studied here it would seem that a firm that engages in outsider trading would escape liability under the fiduciary duty doctrine. This is because the employees of the trading firm owe no duty to the shareholders of the competitor firm and without a duty there cannot be a breach of duty.

The misappropriation theory holds a defendant liable if he trades with material non-public information and the defendant breaks a fiduciary duty to the source of that information. In other words, the defendant is held guilty if he misappropriates the information and uses it for trading. In this paper I study the case of a firm that generates its own non-public information and then takes positions in the financial instruments of other companies in order to benefit from this information. There is therefore no misappropriation since the defendant, the dealing firm, is not violating a fiduciary duty to the source of the information because the source of the information is the same dealing firm. Consequently, it appears unlikely that the trading firm could be found guilty of insider trading under the misappropriation doctrine.

In sum, it seems that the trading firm can escape sanctions under Section 10. This loophole was pointed out in Olsen et al (1985), which states:

“... absent application of rule 14e-3, which is limited to tender offers, and application of the misappropriation theory, insiders of one corporation

⁴ Black's Law Dictionary defines tippees as:

“In securities law, person who acquires material non-public information from another who enjoys a fiduciary relationship with the company to which such information pertains. Persons given information by insiders in breach of trust.”

apparently may use material, non-public information to trade in the securities of another corporation."(p.247).

In conclusion, therefore, it would appear that the outsider trading actions described in the models below would seem to be illegal in the EU but legal in the US.

3.3. Predatory Pricing When Products Are Strategic Substitutes

In this section I describe the predation model based on goods that are strategic substitutes.⁵ In the model there are two publicly quoted firms. Label them Firm A (the predator) and Firm B (the prey). They both sell a perfectly homogenous commodity.

Demand is given by the following linear inverse demand function

$$\begin{aligned} P &= 1 - q_A - q_B \\ &= 0 \text{ if } q_A + q_B \geq 1 \end{aligned}$$

Where the subscripts indicate the firm. I simplify by assuming that the firms have zero marginal production costs. The two firms must pay a sunk cost in each period they produce. Let this sunk cost equal $F_A < 1/9$ for Firm A and $F_B < 1/9$ for Firm B⁶

The time line of the game is as follows:

1. Firm A sells short the shares of Firm B.
2. Firm B learns about this.
3. Firm B chooses to: a) pay the sunk cost F_B and produce; or b) exit the market.
4. Production, collection of revenues and declaration of liquidating dividend.
5. Firm A closes its short position in Firm B.

⁵ The term strategic substitutes originates from Bulow, Geanakoplos and Klemperer (1985).

⁶ F_A and F_B are set to below $1/9$ in order to ensure that both firms have make a strictly positive profit.

Given this structure the game is a two stage game and the relevant solution concept is subgame perfect Nash equilibrium. Before I solve the game though I give a more precise description of the time line.

3.3.1. Description of Time Line

1. Firm A takes a negative position in the shares of Firm B, with Firm B unaware of this. By the phrase 'taking a negative position' I mean that Firm A invests in financial instruments that will allow it to profit from the fall in the share price of Firm B. This may involve selling Firm B short, in which case the shares would be sold now and bought back later, or it may involve the purchase of put options that are based on the underlying shares. In order to calculate the value of these financial transactions we must assign a value to the share price of Firm B. The usual way to obtain the share price is to calculate the present value of the future dividends. It is known that in the absence of strategic behaviour, which financial markets do not expect to occur, the market will be a Cournot duopoly that lasts one period. The profits the stock market expects from Firm B are therefore $\frac{1}{9} - F_A$. Since we are dealing with only one production period this figure of $\frac{1}{9} - F_A$ is also taken to be the initial share price of Firm B. The market is assumed to be unaware of the predation strategy and the private knowledge of the predation strategy allows Firm A to make supra-normal profits in the financial assets market.

Rather than develop a detailed model of the financial market I follow Hansen and Lott (1995) and introduce the parameter $0 \leq \beta \leq 1$. The parameter β represents the change in the value of Firm B that Firm A is able to appropriate. So if the fall in the value of Firm B was x then by going short and taking options positions the total change in value that could be appropriated by Firm A would be βx . I therefore model all the financial profits that are made as β times the change in the share price.⁷

⁷ β can also be interpreted as incorporating the reaction of the financial market makers. A smaller β would mean that the market makers were more responsive to the demand and supply conditions in the market. In the case studied here Firm A wishes to take a very large short position in the shares of Firm B. This desire to sell the shares of Firm A, a large supply, may lead to the price falling, depending on the responsiveness of the market makers. A fall in the selling share price, or, alternatively, a rise in the buying price, would reduce the supranormal profits that Firm B could make. See Leland (1992) for an insider dealing model along these lines.

In order to concretize the description below I talk about selling the share short, if this were to be the only financial strategy adopted by Firm A then one could think of β as the proportion of Firm B's shares that Firm A is able to sell short. By going short Firm A enters into an agreement to sell the shares now and buy them back later, at a lower price, after it has enacted the predation strategy.

2. After it has taken the short position Firm A then communicates this information to Firm B. The implicit assumption is therefore that the trading strategy is observable.
3. Firm B now makes the decision of whether to pay F_B and produce, or exit the market.
4. If Firm B decides to stay in the market then the firms compete à la Cournot. Otherwise Firm A acts a monopolist. After production the revenues are collected and the profit levels are announced to the market. The firms then promise to pay these profits out as a liquidating dividend. The public announcement of the profit levels leads a change in the share prices of the firms.
5. Firm A closes its trading position after Firm B's share price has changed.

This is an opportune moment to describe the information assumptions. Firm A has complete and perfect information. Firm B has complete and perfect information about the market parameters and the amounts produced. With regard to the trading strategy, Firm B is unaware of the trading strategy until Firm A announces it. The market knows only the current profit level. Having fully described the game I now go on to solve the game through backwards induction. I therefore solve the Stage Two production game first.

Proposition 12: If both firms produce output in Stage Two then the profits are the following:

$$\Pi_A = \frac{1}{(3+\beta)^2} + \frac{\beta}{9} - F_A$$

$$\Pi_B = \frac{1}{(3+\beta)^2} - F_A$$

Proof: The maximisation function of Firm A is made up of two parts: the product market profits and the trading profits. This is shown below:

$$\Pi_A = (1 - q_A - q_B)q_A + \beta \left(\frac{1}{9} - (1 - q_A - q_B)q_B \right)$$

Where

$(1 - q_A - q_B)q_A$ are the standard product market profits, and

$\beta \left(\frac{1}{9} - (1 - q_A - q_B)q_B \right)$ is the change in the share price of Firm B, multiplied by β .

This gives a reaction function for Firm A of⁸

$$\tilde{R}_A(q_B) = \frac{1 - q_B}{2} + \beta \left(\frac{q_B}{2} \right)$$

The reaction function of Firm B is the usual Cournot Reaction function

$$\tilde{R}_B(q_A) = \frac{1 - q_A}{2}$$

Substituting and manipulating the reaction functions gives the following results.

$$q_A = \frac{1 + \beta}{3 + \beta}, q_B = \frac{1}{3 + \beta}, P = \frac{1}{3 + \beta}$$

The profits for Firm B are

$$\Pi_B = \frac{1}{(3 + \beta)^2} - F_B$$

and therefore the profits of Firm A

$$\Pi_A = \left(1 - \frac{1}{3 + \beta} - \frac{1 + \beta}{3 + \beta} \right) \frac{1 + \beta}{3 + \beta} + \beta \left(\frac{1}{9} - \frac{1}{(3 + \beta)^2} \right) - F_A$$

⁸ The second order condition is fulfilled since $\frac{d^2 \Pi_A}{d^2 q_A} = -2$.

Which simplifies to

$$\Pi_A = \frac{1}{(3+\beta)^2} + \frac{\beta}{9} - F_A$$

■

Proposition 13: If Firm B does not produce in Stage Two then the profits are the following:

$$\Pi_A = \frac{1}{4} + \beta\left(\frac{1}{9} - F_A\right), \quad \Pi_B = 0$$

Proof: Follows from the initial value of Firm B and the monopoly profits of $\frac{1}{4}$ ■

Having worked out the equilibrium profits we can now move to Firm B's decision of whether to produce or exit the market.

Corollary 14: In Stage One Firm B will decide to produce output if $\frac{1}{(3+\beta)^2} - F_B > 0$ and Firm B will exit the market if $\frac{1}{(3+\beta)^2} - F_B \leq 0$.

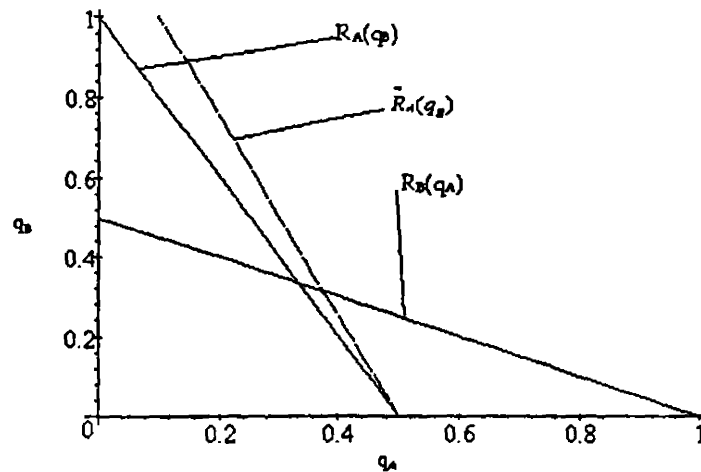
Proof: In Stage One Firm B has the choice between two options. It can pay F_B and produce or exit the market. Its Cournot-Nash equilibrium profits will be $\frac{1}{(3+\beta)^2} - F_B$. Only if this value is bigger than zero will it decide to produce since its alternative is to exit the market and obtain profits of zero. ■

In sum, there are two subgame perfect equilibria. When $\frac{1}{(3+\beta)^2} - F_B \leq 0$ Firm B exits the market and Firm A obtains the monopoly profits. In the other, when $\frac{1}{(3+\beta)^2} - F_B > 0$ Firm B remains in the market and the profits are $\Pi_A = \frac{1}{4} + \frac{\beta}{9} - F_A$ and $\Pi_B = \frac{1}{(3+\beta)^2} - F_B$.

3.3.2. Analysis and Comparative Statics

The results above show that the use of the outsider trading strategy means that Firm A can credibly commit to increasing its output. The diagram below shows the standard Cournot reaction functions of the form $q_A = \frac{1-q_B}{2}$ and $q_B = \frac{1-q_A}{2}$. It also shows the position of the new reaction function of Firm A, marked as $\tilde{R}_A(q_B)$ for a β value of 0.2. In the standard strategic substitutes models, like Dixit (1990), the firm takes an action that shifts its reaction function outwards. Here there is a clockwise rotation of the reaction function rather than a shift. The effect is the same though, Firm A increases its output and Firm B reduces its output. This is because the products are strategic substitutes. Firm B's best response to an increase in output by Firm A is to decrease output; Firm B's best response is to act less aggressively when Firm A acts aggressively. The result of this is an increase in the product market profits of Firm A and a decrease in the profits of Firm B. Although the price falls Firm A produces more and so its total revenue increases. Firm B produces less and sells its production at a lower price, so its profit level falls. Without outsider trading the revenues of Firm B were $\frac{1}{9}$, its new revenues are $\frac{1}{(3+\beta)^2}$. Whether this new lower profit level of $\frac{1}{(3+\beta)^2}$ is higher or lower than Firm B's sunk costs will determine whether Firm B stays in the market or exits the market. If $\frac{1}{(3+\beta)^2} > F_B$ then Firm B will remain in the market. If $\frac{1}{(3+\beta)^2} \leq F_B$ then Firm B will decide to exit the market. It is therefore clear that higher levels of F_B make Firm B more likely to exit the market.

Figure Five: Effect of Outsider Trading on Reaction Functions



In the language of Fudenberg and Tirole (1984) Firm A plays a *Top Dog* strategy. The enactment of the predation strategy makes Firm A *tougher* because the predation strategy reduces the profits of Firm B. This, when combined with the fact that the products are strategic substitutes, leads to the optimality of the *Top Dog* strategy.

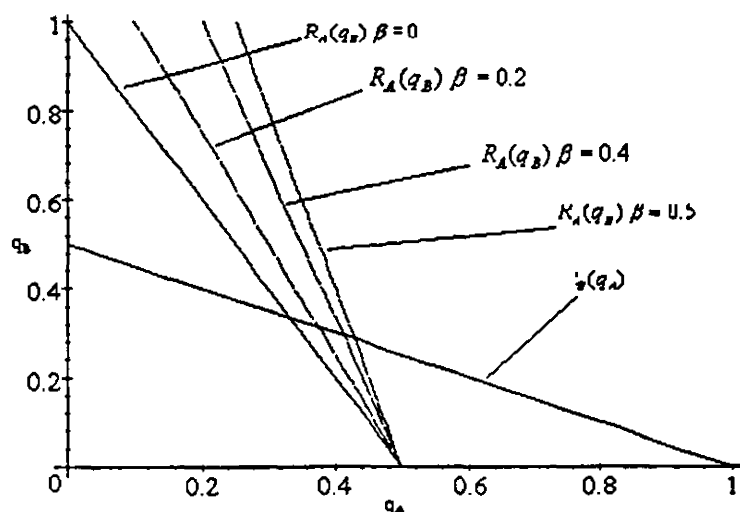
Returning to the increase in the profit levels of Firm A, the benefit of the outsider trading strategy to the predatory firm is clear. The strategy gives Firm A an added reason for increasing its output. Normally in predation models the predating firm has to forego some short-run profits in order to obtain the larger monopoly profits in the long run. Here the product market profits of Firm A actually increase when it is carrying out the predation strategy (it is easily shown that $\frac{1+\beta}{(3+\beta)^2} - F_A > \frac{1}{9} - F_A$). So the product market profits obtained

when engaging in the predation strategy are higher than the profits obtained in the standard Cournot Nash Equilibrium. Furthermore, this increase makes the predation strategy more credible because the increased output is a best response in the subgame. The increased profitability of predation also goes some way to countering McGee's (1958) observation that predation is unlikely because merger is a more profitable strategy. Here the use of outsider trading increases the profitability of predation, thus making it more likely.

3.3.2.1 Comparative Statics w.r.t. β

The diagram below shows the effect of an increase in β

Figure Six - β Comparative Statics



An increase in β leads to the Nash equilibrium output consisting of a higher level of output for Firm A and a lower level of output for Firm B. The net effect is an increase in output and therefore the price is lower. β has differing effects on the profits of the firms. An increase in β increases the profits of Firm A since it *toughens* its stance and allows it to profit from the change in the value of Firm B. In contrast an increase in β decreases the profits of Firm B since it leads to Firm B producing less. This decrease in output reduces the revenue of Firm B and thus its profits.

3.3.3 Summary

The use of outsider trading solves the commitment problem for the predatory firm. Taking a short position in the other firm increases the aggressiveness of the predatory firm and makes the threat of predation credible. This is due to the fact that the goods are strategic substitutes. Acting aggressively increases the predator's profits and reduces the target's profits. The use of outsider trading also leads to an increase in current profits. This contrasts with the standard predation literature where the decrease in current profits is justified by the desire for increases in future, post predation, profits. However, the appendix shows that this result only holds for strategic substitutes. If the products are strategic complements then the standard predation result applies: the firm has to be sure of large trading profits, or that the target will exit, before it engages in predation.

34. Cartel Stability and Outsider Trading

In this section I discuss the effect of outsider trading on the stability of cartels. Below I show that the addition of outsider trading opportunities makes cartels less stable. This is because these opportunities increase the payoff from deviating from the cartel.

The model is set up with the following assumptions. There are n firms in the industry, interacting in a infinitely repeated number of production periods. In each production period the demand function is linear and the price is given by $p = 1 - Q$, where $Q = \sum_{i=1}^n q_i$. The cost of production is set to zero. Each firm's profit is π_i and $\Pi = \sum_{i=1}^n \pi_i$. I assume that the firms compete à la Cournot and therefore in each period the firm's strategy space is the decision of what quantity to produce. When they are in the cartel this is the decision of whether to produce the cartel output or to deviate and cheat on the cartel. I assume that if the cartel breaks down the firms produce the Cournot output forever.

When we move to the model including the opportunity to use outsider trading strategies the structure of the model becomes more complicated. The assumptions about the market made above hold but it is now necessary to make additional assumptions about the outsider trading strategy. Like the previous model I concentrate on the decision of one firm, Firm A, and its decision of whether or not to break the cartel. The decision of Firm A boils down to the following two options:

1. Take a negative position in the other cartel members and then break the cartel; or
2. Stay in the cartel.

Remaining in the cartel simply implies that all the firms, including Firm A, produce the cartel output in every one of the periods. The decision to break the cartel is more complicated and is described below.

If Firm A takes this path then it first takes a negative position in the financial instruments of the other firms. By the phrase 'taking a negative position' I mean that Firm A invests in financial instruments that will allow it to profit from the fall in the share prices of the other

cartel members. This may involve selling the other cartel members short, in which case the shares would be sold now and bought back later, or it may involve the purchase of put options that are based on the underlying shares. In order to calculate the value of these financial transactions it is necessary to assign a value to the share prices of the other cartel members. The usual way to calculate the share price is to calculate the present value of the future dividends. In this model I assume that the cartel members have already produced in the market in the past and previously produced the cartel output. This means that each firm produces an output of $\frac{1}{2n}$ and the per period profits for each firm are $\frac{1}{4n}$. The profits the stock market expects from each cartel member are therefore $\frac{1}{4n}$. Since the game is repeated over an infinite number of period the share price of the cartel members will be the present value of an infinite stream of $\frac{1}{4n}$. If the discount factor is δ , $0 < \delta < 1$, then the share price of each cartel member will be $\frac{1}{4n(1-\delta)}$. The implicit assumption is therefore that the market knows only the current profit levels. The private knowledge of the cartel and its decision to break it allows Firm A to make supra-normal profits in the financial assets market.

Rather than develop a detailed model of the financial market I follow Hansen and Lott (1995) and introduce the parameter $0 \leq \beta \leq 1$. The parameter β represents the change in the value of each cartel member that Firm A is able to appropriate. So if the fall in the value of a cartel member was x then by going short and taking options positions the total change in value that could be appropriated by Firm A would be βx . I therefore model all the financial profits that are made as β times the change in the share price.⁹

In order to concretize the description below I talk about selling the share short, if this were to be the only financial strategy adopted by Firm A then one could think of β as the proportion of Firm B's shares that Firm A is able to sell short. By going short Firm A enters

⁹ β can also be interpreted as incorporating the reaction of the financial market makers. A smaller β would mean that the market makers were more responsive to the demand and supply conditions in the market. In the case studied here Firm A wishes to take a very large short position in the shares of Firm B. This desire to sell the shares of Firm A, a large supply, may lead to the price falling, depending on the responsiveness of the market makers. A fall in the selling share price, or a rise in the buying price, would reduce the supranormal profits that Firm B could make. See Leland (1992) for an insider dealing model along these lines.

into an agreement to sell the shares now. Firm A will then buy them back later, at a lower price, after it has broken the cartel.

If Firm A deviates from the cartel then it will increase its output. Firm A's increase in output will have two effects. First, it will lead to a change in the product market profits of Firm A due to the increase in output. Second, this increase will also affect the profits of the other cartel members. Their profit levels will fall in the deviation stage and therefore their share price will fall as well. As was stated above, the market assumes that the profit obtained in the current period will continue forever. After it has produced the deviation output Firm A closes its position in the shares of the other firms. It does this by buying back the shares at their new lower price.

At this point it makes sense to clearly define the information assumptions. Firm A has complete and perfect information. The other cartel members are completely unaware of the trading strategy but have complete and perfect information about the market parameters and the amounts produced. The stock market knows only the current profit level, and prices the shares accordingly.

After the deviation stage the firms return to producing the Cournot output in every one of the remaining periods.

Returning to the deviation stage, when Firm decides to break, it is necessary to change the maximisation function of Firm A to include the opportunities available from outsider trading. The maximisation function of Firm A in the deviation stage is:

$$\Pi_A = \left(1 - q_A - (n-1)\frac{1}{2n}\right)q_A + \beta \frac{n-1}{1-\delta} \left(\frac{1}{4n} - \left(1 - q_A - \frac{n-1}{2n}\right)\frac{1}{2n}\right)$$

Where :

$\left(1 - q_A - (n-1)\frac{1}{2n}\right)$ is the price in the product market

q_A is the quantity produced by Firm A

β is the proportion of the change in value of the other individual firms that is appropriable by Firm A

$(n-1)$ is the number of firms, other than the trading firm, in the market

$\frac{1}{1-\delta}$ gives the share price of the other firms as a function of the current profit levels

$(\frac{1}{4n} - (1-q_A - \frac{n-1}{2n})\frac{1}{2n})$ is the change in the profits of the other firms in the cartel; $\frac{1}{4n}$ is the original level of per period profits and $(1-q_A - \frac{n-1}{2n})\frac{1}{2n}$ will be the total profits of the other firms in the deviation stage.

Maximising this with respect to q_A gives

$$q_A = \frac{n+1}{4n} + \beta \frac{n-1}{4n(1-\delta)}$$

However, this output can never lead to a price below zero, so the limit on q_A is

$$1 - q_A - (n-1)\frac{1}{2n} \geq 0.$$

This translates into the following values for q_A in the deviation stage

$$q_A = \begin{cases} \frac{n+1}{2n} & \text{if } \beta \geq \frac{(1-\delta)(n+1)}{n-1} \\ \frac{n+1}{4n} + \beta \frac{n-1}{4n(1-\delta)} & \text{if } \beta < \frac{(1-\delta)(n+1)}{n-1} \end{cases}$$

When β is large Firm A is able to appropriate a large proportion of the change in value of the firms. If β is above the cut off value of $\frac{(1-\delta)(n+1)}{n-1}$ then the gains from forcing the other firms' share prices down are large enough to make it optimal to drive the price in the deviation stage to zero. In this case there is a corner solution and although Firm A does not gain any excess profits from cheating on the cartel in the deviation stage it obtains large profits from outsider trading.

When β is smaller the optimal deviation output results in a strictly positive price in the deviation stage. With a smaller β the gains from outsider trading are smaller and it is therefore the best response is an internal solution that results in a positive price.

In the following I therefore split the discussion into two parts. First I discuss the case when β is large ($\beta \geq \frac{(1-\delta)(n+1)}{n-1}$), the deviation output level is equal to $\frac{n+1}{2n}$, and the price in the deviation stage falls to zero. I then discuss the case when β is not so large ($\beta < \frac{(1-\delta)(n+1)}{n-1}$), the deviation output is $\frac{n+1}{4n} + \beta \frac{n-1}{4n(1-\delta)}$, and the price in the deviation stage is strictly positive.

3.4.1. $P = 0$ In The Deviation Period ($\beta \geq \frac{(1-\delta)(n+1)}{n-1}$)

Proposition 15: With ($\beta \geq \frac{(1-\delta)(n+1)}{n-1}$) the cartel stability condition for δ is:

$$\frac{(1 - \beta(n-1))(n+1)^2}{4n} > \delta$$

Proof: Given ($\beta \geq \frac{(1-\delta)(n+1)}{n-1}$) the Incentive Compatibility Constraint (ICC) of the deviating firm will be a comparison of the following: On the one hand there are the cartel profits which are $\frac{1}{4n(1-\delta)}$. On the other hand there are the deviation profits, which are zero since

$P = 0$ in the deviation stage, plus the trading profits of $\beta \frac{n-1}{1-\delta} (\frac{1}{4n})$, plus the future stream of Cournot profits of $\frac{\delta}{(1-\delta)(n+1)^2}$. The trading profits are $\beta \frac{n-1}{1-\delta} (\frac{1}{4n})$, since the share price of the other firms will fall to zero as the profits fall to zero.

The condition for remaining in the cartel, the ICC, is therefore:

$$\frac{1}{4n(1-\delta)} > \beta \frac{n-1}{1-\delta} (\frac{1}{4n}) + \frac{\delta}{(1-\delta)(n+1)^2}$$

Which translates into the following condition on the discount factor:

$$\frac{(1 - \beta(n-1))(n+1)^2}{4n} > \delta$$

■

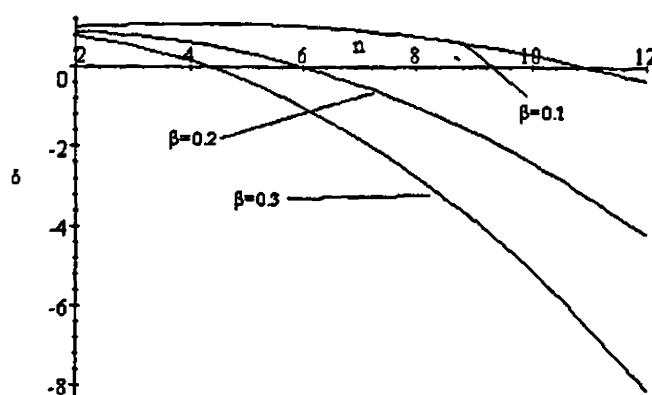
3.4.1.1. *Analysis and Comparative Statics*

The sign of the inequality above contrasts with the usual cartel stability condition. In standard cartel stability models the firm will break the cartel if the discount factor is low. This is because the benefits from staying in the cartel are the continuing monopoly profits in the future. This is compared to the sum of short term one period deviation profits that one obtains by cheating on the cartel plus the following Cournot profits. Therefore, the higher the discount factor the more one cares about those future cartel profits and the less likely one is to break the cartel. This is not the case when $\beta \geq \frac{(1-\delta)(n+1)}{n-1}$. Here the cartel is only stable if the discount factor is low. Why this is true is explained below.

In the trading model above the discount factor also enters into the share price of the non trading firms. Simple maths shows that the current level of the share price increases as the discount factor increases. Therefore the trading profits increase as the discount factor increases, $\left(\frac{d}{d\delta} \left(\beta \frac{n-1}{1-\delta} \left(\frac{1}{4n} \right) \right) = \frac{\beta(n-1)}{4(\delta-1)^2 n} > 0 \right)$ an increase in the discount factor leads to increased trading profits. These large trading profits increase the incentives for breaking the cartel.

The effect of δ on the share price works in the opposite direction to the standard discount factor effect. With a large β the effect on the share price dominates. Therefore under these parameter conditions δ has to be small for the cartel to survive. The exact effect is shown on the diagram below for different levels of β .

Figure Seven: β Comparative Statics



On the diagram above the top line represents $\beta = 0.1$, the middle $\beta = 0.2$ and the bottom $\beta = 0.3$. The discount factor must be below the line so one can see that as β increases it becomes more and more difficult for the cartel to survive.

3.4.2. $P > 0$ In the Deviation Period ($\beta < \frac{(1-\delta)(n+1)}{n-1}$)

Proposition 16: $\beta < \frac{(1-\delta)(n+1)}{n-1}$ the quadratic cartel stability condition on δ is

$$0 > \delta^2(n^2 + 6n + 1) - 2\delta(n^2 + 4n + 1 + \beta(n+1)^2) + \beta(n+1)^2(\beta + 2) + (n+1)^2$$

Proof: Given $\beta < \frac{(1-\delta)(n+1)}{n-1}$ the Incentive Compatibility Constraint (ICC) of the deviating firm will be a comparison of the following: On the one hand there are the cartel profits which are $\frac{1}{4n(1-\delta)}$. On the other hand there are the deviation profits and trading profits, which are described below, and the future stream of Cournot profits of $\frac{\delta}{(1-\delta)(n+1)^2}$.

The profits in the deviation stage are equal to the sum of the product market profits and the trading profits. These are shown below

$$\begin{aligned} \Pi_A = & (1 - (\frac{n+1}{4n} + \beta \frac{n-1}{4n(1-\delta)}) - (n-1) \frac{1}{2n}) (\frac{n+1}{4n} + \beta \frac{(n-1)}{4n(1-\delta)}) \\ & + \beta \frac{n-1}{1-\delta} (\frac{1}{4n} - (1 - (\frac{n+1}{4n} + \beta \frac{n-1}{4n(1-\delta)}) - \frac{(n-1)}{2n}) \frac{1}{2n}) \end{aligned}$$

This simplifies to:

$$\begin{aligned} \Pi_A = & (\frac{n+1}{4n} - \frac{\beta(n-1)}{4n(1-\delta)}) (\frac{n+1}{4n} + \frac{\beta(n-1)}{4n(1-\delta)}) \\ & + \frac{\beta(n-1)}{1-\delta} (\frac{n-1}{8n^2} - \frac{\beta(n-1)}{8n^2(1-\delta)}) \end{aligned}$$

These deviation profits are slid into the following cartel incentive compatibility constraint:

$$\begin{aligned} \frac{1}{4n(1-\delta)} > & (\frac{n+1}{4n} - \frac{\beta(n-1)}{4n(1-\delta)}) (\frac{n+1}{4n} + \frac{\beta(n-1)}{4n(1-\delta)}) \\ & + \frac{\beta(n-1)}{1-\delta} (\frac{n-1}{8n^2} - \frac{\beta(n-1)}{8n^2(1-\delta)}) + \frac{\delta}{(1-\delta)(n+1)^2} \end{aligned}$$

The condition above simplifies to the following quadratic condition on δ

$$0 > \delta^2(n^2 + 6n + 1) - 2\delta(n^2 + 4n + 1 + \beta(n+1)^2) + \beta(n+1)^2(\beta + 2) + (n+1)^2 \blacksquare$$

3.4.2.1. Analysis and Comparative Statics

Here β is relatively small and so the price in the deviation stage is strictly positive. The Incentive Compatibility constraint obtained for the case when outsider trading is possible, and $\beta < \frac{(1-\delta)(n+1)}{n-1}$ is the following:

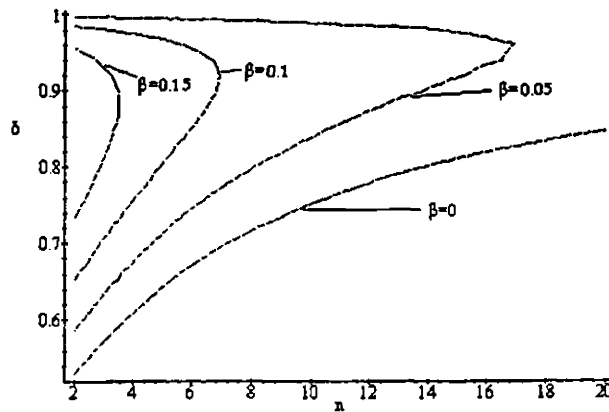
$$0 > \delta^2(n^2 + 6n + 1) - 2\delta(n^2 + 4n + 1 + \beta(n+1)^2) + \beta(n+1)^2(\beta + 2) + (n+1)^2$$

If we set the right hand side equal to zero then we can obtain the two quadratic roots of the above equation. These roots take the values¹:

$$\delta_{x,y} = \frac{1}{2(n^2 + 6n + 1)} (2 + 2\beta n^2 + 4\beta n + 2\beta + 8n + 2n^2) \pm 4\sqrt{(n^2 - \beta^2 n - 2\beta^2 n^2 - 2\beta n^2 - \beta n - \beta^2 n^3 - \beta n^3)}$$

These two roots are plotted on the diagram below for some values of β . The line to the far left line is for $\beta = 0.15$, then $\beta = 0.1$, then $\beta = 0.05$, and then $\beta = 0$ (the case of no outsider trading).

Figure Eight: β Comparative Statics



¹ Note that if $\beta = 0$ these simplify to $\delta_x = 1$ and $\delta_x = \frac{(n+1)^2}{n^2 + 6n + 1}$, the standard results.

The area to the left of the two lines is the area where the cartel is stable and deviation is not optimal. The reason for the upper and lower bound on the stability of cartels is the dual role of δ in the model: δ affects the share price of the other firms (as described above) and the value of the future cartel profits lost by breaking the cartel. The interaction of these effects results in the two boundaries. If δ is too high the resulting high share price changes mean that the trading profits from breaking the cartel are large, and so it is optimal to produce the deviation output and break the cartel. If δ is very low then the dominant effect is the low value the deviating firm puts on the future cartel profits. It is therefore optimal to break the cartel since the instant increase in profits is more than enough to compensate for the loss of future cartel profits.

One can also see that the addition of outsider trading reduces the parameter window that leads to successful collusion. With no outsider trading the cartel is stable in the area above the line for $\beta=0$. When one includes outsider trading opportunities the window which supports collusion becomes much smaller, and gets smaller as β increases. This leads us to a discussion of the comparative statics.

The comparative statics are complicated by the fact that there are two solutions for each value of n . It is therefore impossible to sign the derivatives as they are different depending on which section of the line we are dealing with. The derivative with respect to β is positive ($\frac{d\delta}{d\beta} > 0$), so the incentive compatibility constraint is harder to fulfil. An increase in the level of β always makes the firm more likely to break the cartel as it increases the trading profits that are obtained from deviating from the cartel. This effect is always bigger than the countervailing effect. This countervailing effect is the fact that a higher β reduces the deviation profits. This is because a higher β Firm A to be more aggressive and hurt its opponents more, this larger increase output unfortunately hurts Firm A as well as it suffers from the high output it dumps on the market in the deviation game.

3.4.3. Cartel Stability and Long Positions

In this section I discuss the problems associated with taking a long position in one's fellow cartel members. Malueg (1992) deals with the effects of partial equity holdings in one's fellow cartel members. These partial equity holdings allow the cartel members to distribute their profits around the participating firms. If Firm A has an equity stake of 20% of Firm B,

and vice versa, then 20% of the profits that Firm A makes go to Firm B, and vice versa. Malueg (1992) therefore deals with only one part of the benefits of holding a stake in the equity of a firm in the same industry: one obtains a share of their profits. The other benefit is that one can benefit from changes in the share prices of firms in the same industry. It is the second benefit I concentrate on, to the extent that I ignore the first.

It may appear that taking long positions in the shares of the other cartel members may lead to a cartel becoming more stable. In the following I show why when short positions are also allowed this is not true.

The standard cartel incentive compatibility constraint is given below:

$$\frac{\Pi_M}{1-\delta} > \Pi_D + \frac{\delta \Pi_C}{1-\delta}$$

Where Π_M are the per period cartel profits, Π_D the deviation profits, Π_C the Cournot per period profits, and δ is the discount factor. As is well known, the firms will only stay in the cartel if the discount rate is sufficiently high.

The cartel can be made more stable (supportable with a lower discount factor) if an extra cost is added to the right hand side of this equation. This is where the use of long positions becomes useful. If the cartel members hold long positions in each other then they will experience a loss if the share prices of the other members falls. Let the absolute value of this loss be denoted by L . The new incentive compatibility constraint is

$$\frac{\Pi_M}{1-\delta} > \Pi_D + \frac{\delta \Pi_C}{1-\delta} - L$$

The addition of a negative value to the RHS makes the condition easier to fulfil. Therefore it should be possible to support cartels with a discount rate which is lower than that required by a standard cartel. The standard cartel discount factor incentive constraint is $\delta > \frac{\Pi_D - \Pi_C}{\Pi_M - \Pi_C}$.

With the addition of L this condition becomes $\delta > \frac{\Pi_D - \Pi_C - L}{\Pi_M - \Pi_C - L}$. The derivative of this condition

with respect to L is negative. So as the loss increases the cartel becomes more stable. Situations may therefore arise when the firms cannot credibly commit to remain in a cartel,

due to low discount factors, but were they to all agree to take long positions in each other then they could then credibly commit to not cheating on the cartel. In this way the use of long positions could be used to support unstable cartels.

However, there is a problem with this argument. In the section on the use of short positions the assumption was made that it was possible to build up a short position without the other cartel members knowing this. Therefore, to be consistent, one should make the same assumption here. If this is the case then it would be possible to build up a short position which cancels out the long position which is already held. The net result would be that the firm with the long and short position would be in the same situation as a firm without a trading position. It would therefore face the standard incentive cartel incentive constraint and would break the cartel. This is because the reason the long position were taken in the first place was to shore up a previously unstable cartel. Knowing that this could occur no firm could credibly commit to maintaining a long position. With credible commitment not possible no firm would take a long position and the cartel would break down.

3.5. Conclusion

The aim of this paper was to study the effects of outsider trading opportunities on the incentives to predate and the stability of cartels. The results for the predation models are heavily affected by whether one assumes the products are strategic substitutes or strategic complements.

With strategic substitutes outsider trading is very effective and makes successful predation much more likely. The fact that the predator can, by taking a short position, gain extra trading profits when predation leads to a drop in the profits and share price of the target firm makes predation more profitable and makes the threat of predation more credible. The results show that with outsider trading the predating firm actually increases its profits when it is predating, and does not have to rely on the promise of future profits to justify predation. This credibility effect of outsider trading is very similar to the effect of investment in capacity in Dixit (1980), as it leads to a shift in the reaction function of the predating firm. In other words taking a short position is a Top Dog strategy, according to the taxonomy of Fudenberg and Tirole (1984).

When the products are strategic complements outsider trading is a much less effective tool when predating. Although outsider trading leads to a reduction in the profits of the target firm, this reduction is much smaller than when the products are strategic substitutes. This is because when the products are strategic complements the best response of the target firm to an aggressive move by the predator is a similarly aggressive move. The predator, knowing that any predatory price cut will lead to the target firm also cutting its price, is loath to reduce its price because this will result in a very damaging price war. The predator's incentives to reduce prices are much weaker, because it will suffer large losses, and the results show that predation will only be carried out when it leads to the immediate exit of the target firm.

The study of cartels and outsider trading shows that outsider trading always makes cartels less stable. Short positions increase the incentives to break the cartel, as the deviating firm can profit from the fall in profits and thus share prices of its fellow cartel members. Furthermore, short positions can also be used to negate any long positions that were used to shore up a weak cartel. A long position in the shares of fellow cartel members means that any firm deviating from the cartel will incur an extra loss due to the fall in value of these holdings. This increases the costs of deviating, and thus could lead to cartels being more stable. However, since one can easily build up a short position to negate this long position, long positions cannot be used to commit credibly to joining a cartel. Therefore outsider trading always makes cartels less stable.

The normative implications of the above results on outsider trading are unclear. For insider trading there is a wealth of studies showing that its welfare effects are ambiguous. On the one hand insider trading may lead to faster and better information incorporation, on the other hand outsiders may demand a premium for the risk of losing out to insiders.² For outsider trading the only previous paper is Hansen and Lott (1995). They study the effects of outsider trading on the probability of entry and find that the welfare effects of allowing outsider trading are ambiguous, primarily because the welfare effects of entry are also unclear.³ Here I show that outsider trading leads to predation being more successful, undoubtedly a

² See Leland (1992) and Kyle (1985), or Jain and Mirman (1999) and Repullo (1999) for more recent contributions.

³ Mankiw and Whinston (1986) describe the 'business stealing' effect. When one firm enters it lowers the profits of the others, and since this negative externality is ignored by the entrant there may be excessive entry

negative aspect, but also makes cartels less stable, undoubtedly a positive effect. No clear implications can be drawn, and it is perhaps appropriate that this ambiguity is mirrored in the legislative environment, where outsider trading appears to be legal in the United States, but illegal in the European Union.

APPENDIX A. PREDATORY PRICING MODEL WHEN PRODUCTS ARE STRATEGIC COMPLEMENTS

In this appendix I once again calculate the results for the predation model. The difference this time is that I choose a model where the goods are strategic complements rather than strategic substitutes. Therefore a complication arises. When the goods are strategic complements it is not always certain that the predator firm will obtain higher profits in the predation period. Indeed, I show below that two sufficient conditions for predation to be rational are that β is large (the trading firm can capture a large share of the change in share value) or the sunk recurrent cost of the targeted firm are large. The first condition implies that the large trading profits compensate for the reduction in profits in the product market. The second condition implies that the target firm will exit the market if it is threatened with predation. First though I run through the standard model without outsider trading possibilities in order to allow comparisons.

A.1. Standard Strategic Complements Model

There are two firms, label them Firm A and Firm B, which sell a differentiated good, product A and product B. The degree of differentiation between the products is given by the parameter θ , $0 < \theta < 1$. If $\theta = 0$ the demand for product A is independent of the demand for product B, and vice versa. As θ increases the products' substitutability rises. The individual prices are given by the following linear inverse demand functions:

$$p_A = \begin{cases} 1 - q_A - \theta q_B \\ \text{or } 0 \text{ if } q_A + \theta q_B > 1 \end{cases}$$

$$p_B = \begin{cases} 1 - q_B - \theta q_A \\ \text{or } 0 \text{ if } q_B + \theta q_A > 1 \end{cases}$$

To simplify each firm is assumed to have zero marginal costs of production. The two firms must pay a sunk cost in every period they produce. Let this equal F_A for Firm A and F_B for Firm B.⁴

Proposition 17: In the standard model without outsider trading the profits of the two firms are the following:

$$\Pi_A = \frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_A$$

$$\Pi_B = \frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_B$$

Proof: To analyse price setting behaviour we need to analyse the demand functions, a little manipulation of the inverse demand functions gives:

$$q_A = \frac{1-\theta}{1-\theta^2} - \frac{p_A}{1-\theta^2} + \frac{\theta p_B}{1-\theta^2}$$

$$q_B = \frac{1-\theta}{1-\theta^2} - \frac{p_B}{1-\theta^2} + \frac{\theta p_A}{1-\theta^2}$$

The maximisation function of Firm A is:

$$\text{Max}_{p_A} p_A q_A - F_A$$

which becomes:

$$\text{Max}_{p_A} p_A \left(\frac{1-\theta}{1-\theta^2} - \frac{p_A}{1-\theta^2} + \frac{\theta p_B}{1-\theta^2} \right) - F_A$$

Thus the reaction function of Firm A is:

$$p_A = \frac{1-\theta + \theta p_B}{2}$$

⁴ I assume that F_A and F_B are less than $\frac{1-\theta}{(1+\theta)(2-\theta)^2}$ to ensure that both firms are initially in the market.

A similar result is obtained for Firm B. Further manipulation of the reaction functions gives the following values for price and output:

$$p_A = p_B = \frac{1-\theta}{2-\theta}$$

$$q_A = q_B = \frac{1}{(1+\theta)(2-\theta)}$$

A.2. Model With Outsider Trading

Since with strategic complements Firm A is no longer guaranteed higher profits from the predation strategy it is necessary to expand the structure of the model in order to integrate the initial decision of Firm A. All other aspects of the game remain the same as the original model with strategic substitutes. The time line of the expanded game, which is identical to the game with strategic substitutes except for the decision of Firm A in 1, is as follows:

Time Line

1. Firm A decides whether to take the short position and enact the predation strategy.
2. If Firm A has chosen to predate then Firm B learns about the predation strategy.
3. Firm B chooses to: a) pay the sunk cost F_B and produce; or b) exit the market.
4. Production, collection of revenues and declaration of liquidating dividend.
5. Firm A closes its short position in Firm B.

We therefore have a three stage game. Stage 1 is the decision of Firm A to enact the predation strategy or not. Stage 2 is the decision of Firm B of whether it will pay the sunk cost and produce or exit the market. Stage 3 is the production game. The relevant solution concept is therefore subgame perfect equilibrium and I begin by solving Stage 3 first.

Proposition 18: If both firms compete in Stage 3 then, with the addition of outsider trading, the equilibrium profit levels are:

$$\Pi_A = \frac{2-\theta-\theta^2-\beta\theta+\beta\theta^2}{4-\theta^2+\beta\theta^2} \frac{\beta\theta^2+\theta+\beta\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)} + \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - \frac{2-\theta^2-\theta}{(4-\theta^2+\beta\theta^2)} \frac{\theta+2}{(4-\theta^2+\beta\theta^2)(\theta+1)} \right) - F_A$$

$$\Pi_B = \frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} - F_B$$

Proof: The maximisation function of Firm A is

$$\Pi_A = p_A q_A + \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - p_B q_B \right) - F_A$$

Substituting for the quantities and differentiating to obtain the reaction functions results in the following reaction function for Firm A:

$$p_A = \frac{1-\theta+\theta p_B - \beta \theta p_B}{2}$$

and the reaction function of Firm B is

$$p_B = \frac{1-\theta+\theta p_A}{2}$$

Simple manipulation of the reaction functions gives the equilibrium prices and quantities:

$$\begin{aligned} p_A &= \frac{2-\theta^2+\beta\theta^2-\beta\theta-\theta}{4-\theta^2+\beta\theta^2} & p_B &= \frac{2-\theta^2-\theta}{4-\theta^2+\beta\theta^2} \\ q_A &= \frac{\beta\theta^2+\theta+\beta\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)} & q_B &= \frac{\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)} \end{aligned}$$

These values can then be plugged into the maximisation function to give the profit levels. ■

Proposition 19: If Firm A is the only producer in Stage 3 then the profit levels are the following:

$$\Pi_B = \frac{1}{4} + \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_B \right) \quad \Pi_B = 0$$

Proof: If Firm B exits the market then Firm A acts as a monopolist, sets $p_A = 0.5$ and obtains the monopoly profits of 0.25. Firm B exits the market so its share price is zero and the trading profits are $\beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_B \right)$. ■

Proposition 20: Firm B will decide to pay the sunk cost and produce if

$$\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} > F_B$$

Proof: Firm B has the choice between two options. It can pay F_B and produce or exit the market. As is normal in game theory the player solves backwards. In this case Firm B will calculate that its Stage 3 Nash equilibrium profits will be $\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} - F_B$. Only if this value is bigger than zero will it decide to produce since its alternative is to exit the market and obtain profits of zero. ■

Proposition: The following are sufficient conditions for Firm A to enact the predation strategy

$$\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} < F_B$$

or

$$\beta > \frac{1}{2\theta^2} (\theta^3 - 4 + \sqrt{(\theta^6 + 8\theta^3 + 16 - 4\theta^5)})$$

Proof: If $\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} > F_B$ then Firm A knows that Firm Two will exit the market. In this

case Firm A will act as a monopolist. The profits Firm A earns are:

$$\Pi_B = \frac{1}{4} + \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_B - 0 \right)$$

It is easy to show that

$$\frac{1}{4} + \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_B - 0 \right) - F_A > \frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_A$$

This completes the first part of the proof.

As was shown in Proposition 18 if Firm B stays in the market then Firm B will obtain the following level of profits:

$$\begin{aligned} \Pi_A &= \frac{2-\theta-\theta^2-\beta\theta+\beta\theta^2}{4-\theta^2+\beta\theta^2} \frac{\beta\theta^2+\theta+\beta\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)} \\ &+ \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - \frac{2-\theta^2-\theta}{(4-\theta^2+\beta\theta^2)} \frac{\theta+2}{(4-\theta^2+\beta\theta^2)(\theta+1)} \right) - F_A \end{aligned}$$

This has to be compared to the profits that would be obtained if Firm A was not to enact the predation strategy which would be the following:

$$\frac{1-\theta}{(1+\theta)(2-\theta)^2} - F_A$$

The relevant inequality is therefore:

$$\begin{aligned} &\frac{2-\theta-\theta^2-\beta\theta+\beta\theta^2}{4-\theta^2+\beta\theta^2} \frac{\beta\theta^2+\theta+\beta\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)} \\ &+ \beta \left(\frac{1-\theta}{(1+\theta)(2-\theta)^2} - \frac{2-\theta^2-\theta}{(4-\theta^2+\beta\theta^2)} \frac{\theta+2}{(4-\theta^2+\beta\theta^2)(\theta+1)} \right) > \frac{1-\theta}{(1+\theta)(2-\theta)^2} \end{aligned}$$

This simplifies to

$$-\theta^3 + \beta\theta^3 - \beta^2\theta^2 + 4\theta - 4\beta < 0$$

The roots i and j of the equation

$$-\theta^3 + \beta\theta^3 - \beta^2\theta^2 + 4\theta - 4\beta = 0$$

are:

$$\beta_{i,j} > \frac{1}{2\theta^2}(\theta^3 - 4 + \sqrt{(\theta^6 + 8\theta^3 + 16 - 4\theta^5)})$$

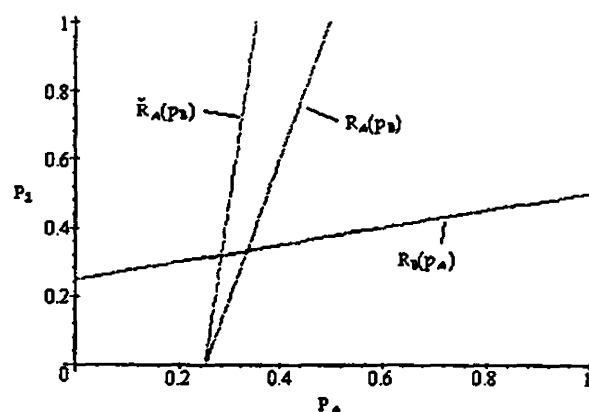
Since $\beta > 0$ the relevant root is $\beta = \frac{1}{2\theta^2}(\theta^3 - 4 + \sqrt{(\theta^6 + 8\theta^3 + 16 - 4\theta^5)})$. This, combined with the fact that $\frac{d}{d\beta}(-\theta^3 + \beta\theta^3 - \beta^2\theta^2 + 4\theta - 4\beta) < 0$ means that the necessary condition for Firm A to increase its profits when Firm B stays in the market is $\beta > \frac{1}{2\theta^2}(\theta^3 - 4 + \sqrt{(\theta^6 + 8\theta^3 + 16 - 4\theta^5)})$. This completes the second part of the proof. ■

3.5.1. Analysis and Comparative Statics

The results for a model with strategic complements differ from the results of a strategic substitutes model in a number of ways. The most significant difference is that it is no longer always optimal to enact the predation strategy. In this one period game Firm A will only engage in predation if at least one of two sufficient conditions is met. The first condition is $\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} < F_s$. If this condition holds then Firm A knows that Firm B will exit the market because it has relatively high sunk costs. Therefore Firm A enacts the predation strategy because it will be a monopolist. The other condition is that $\beta > \frac{1}{2\theta^2}(\theta^3 - 4 + \sqrt{(\theta^6 + 8\theta^3 + 16 - 4\theta^5)})$. In this case β is large so the trading profits are large. The large trading profits are enough to offset the fall in the product market profits, thus the total profits of Firm A rise if it engages in the predation strategy. This contrasts with the results for a model with strategic substitutes, where Firm A will always engage in outsider trading and predation.

On the diagram below I use the reaction functions to explain what happens when Firm A uses outsider trading and a predation strategy.

Figure Nine – Effect of Outsider Trading on Reaction Function



The original reaction functions are drawn for $\theta = 0.5$. As can be seen this leads to an equilibrium price of 0.3. With the addition of outsider trading the reaction function of Firm A rotates in an anticlockwise direction. The diagram above shows the reaction function for $\beta = 0.6$. One can see that the new equilibrium is to the lower left of the original equilibrium points. The products are strategic complements so the best response to an aggressive action is an aggressive action. This joint price cut leads to a point where Firm A obtains smaller profits in the product market (as is shown in Proposition 22 below).

In terms of the animal taxonomies of Fudenberg and Tirole (1984) the predation strategy makes Firm A *tougher*, as an increase in β reduces the profits of Firm B. In the case studied here Firm A is trying to induce the exit of Firm B. This is similar to the deterrence argument so the optimal strategy for Firm A is the *Top Dog* strategy. As was stated before, the main difference between the model with strategic substitutes and the model with strategic complements is that in the latter the predating firm obtains lower revenues in the product market. This is proved below.

Proposition 22: With strategic complements the product market revenues of Firm A drop when it enacts the predation strategy.

Proof: The original revenues of Firm A were

$$\frac{1-\theta}{(1+\theta)(2-\theta)^2}$$

The new product market revenues of Firm A are

$$\frac{2-\theta-\theta^2-\beta\theta+\beta\theta^2}{4-\theta^2+\beta\theta^2} \frac{\beta\theta^2+\theta+\beta\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)}$$

The inequality that proclaims that the new profit levels are smaller is the following

$$\frac{1-\theta}{(1+\theta)(2-\theta)^2} > \frac{2-\theta-\theta^2-\beta\theta+\beta\theta^2}{4-\theta^2+\beta\theta^2} \frac{\beta\theta^2+\theta+\beta\theta+2}{(\theta+1)(4-\theta^2+\beta\theta^2)}$$

This simplifies to the following condition on β

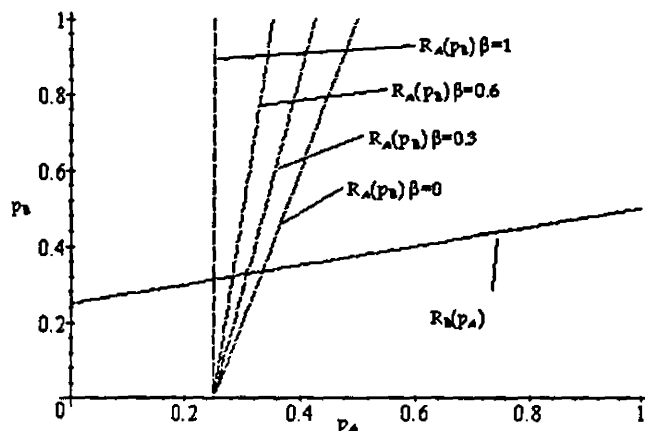
$$\beta > \frac{4\theta-\theta^3}{2\theta^2-4-\theta^3}$$

Which is true if $\beta > 0$ and $0 < \theta < 1$. ■

3.5.1.1. Comparative Statics of β

The diagram below shows the effect of a change in β .

Figure Ten - β Comparative Statics

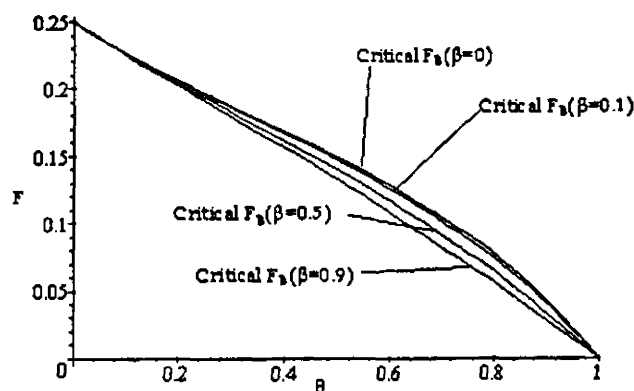


As can be seen, an increase in β rotates the reaction curves anticlockwise. The diagram above contains the reaction functions for $\beta = 0$, $\beta = 0.3$, $\beta = 0.6$ and $\beta = 1$. The use of the predation strategy leads to a reduction in price for both firms ($\frac{dp_A}{d\beta} < 0$ and $\frac{dp_B}{d\beta} < 0$). In terms of quantities this leads to an increase in the output of Firm A ($\frac{dq_A}{d\beta} > 0$) and a decrease in the output of Firm B ($\frac{dq_B}{d\beta} < 0$). The output of Firm B drops despite the price decrease because the large drop in the price of product A shifts demand to product A. The combined effect of the changes in prices and outputs is that an increase in β leads to a reduction in the product market profits of both Firm A and Firm B.

An increase in β leads to an increase in the trading profits of Firm A. The sign of the derivative of the total profits (product market + trading profits) of Firm A w.r.t. β is not able to be signed. This is because of the dual effect mentioned above: a larger β increases the trading profits but also reduces the product market profits.

Another aspect which is affected by β is the cut-off level of sunk costs. As was shown earlier, if $\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} < F_B$ then Firm B will exit the market. The diagram below shows the critical levels of sunk costs for differing levels of β . The top line shows the critical level of sunk costs for $\beta = 0$, then the lower lines are $\beta = 0.1$, $\beta = 0.5$ and $\beta = 0.9$. One can see that on the diagram below the derivative of this condition with respect to β is negative.

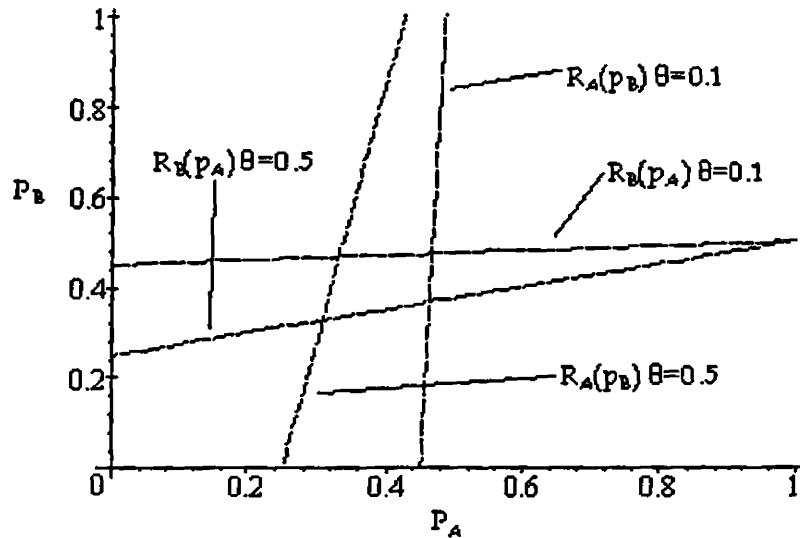
Figure Eleven - Effect of β On Critical Fixed Costs Level



The most striking result is the almost negligible effect the outsider trading option has on Firm B. Even with $\beta = 0.9$ there is very little chance of Firm B exiting the market. In order for Firm B to exit the market F_B would have to be between the top line and the bottom line. This is a very small area of the diagram so the chances of successfully predateding the target out of the market are very low.

3.5.1.2. Comparative Statics of θ

Figure Twelve - θ Comparative Statics

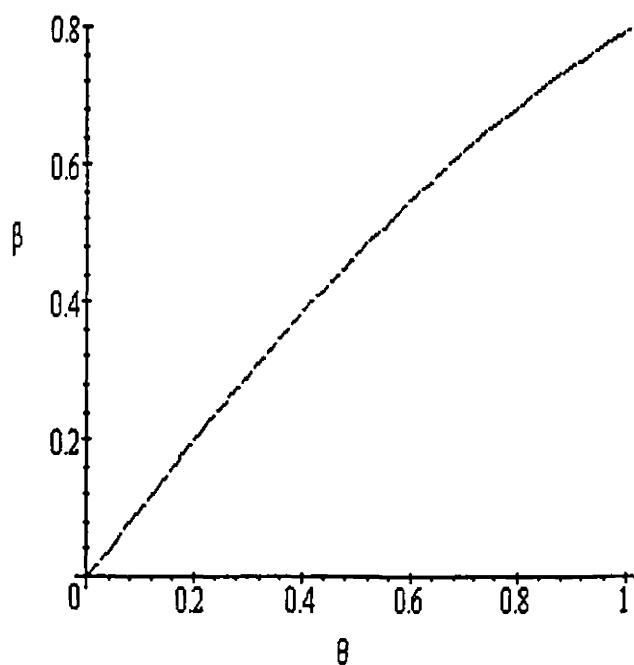


The diagram above shows the effects of changing θ when outsider trading is allowed. The diagram above shows the equilibria for $\beta = 0.3$, and $\theta = 0.5$ and $\theta = 0.1$. One can see that an increase in θ leads to a decrease in price for both firms ($\frac{dp_A}{d\theta} < 0$ and $\frac{dp_B}{d\theta} < 0$). Again this is due to the competition effect. The effect on outputs are unsignable. This is because the individual price cuts have differing effects on the quantity demanded, so the net effect is unknown. The product market profits of Firm A decrease as θ increases because the competition becomes fiercer. However, the effect on the trading profits is unsignable. The combined effect of these two factors is therefore uncertain and it is impossible to sign the derivative of total profits with respect to θ . The derivative of the profits of Firm B is negative ($\frac{d\pi_B}{d\theta} < 0$), reflecting the fact that more substitutability leads to fiercer competition and lower profits.

As was stated at the beginning of the Appendix one of the sufficient conditions for Firm A to enact the predation strategy is a sufficiently high β . The exact condition is

$\beta > \frac{1}{2\theta^2}(\theta^3 - 4 + \sqrt{(\theta^6 + 8\theta^3 + 16 - 4\theta^5)})$ and is graphed below.

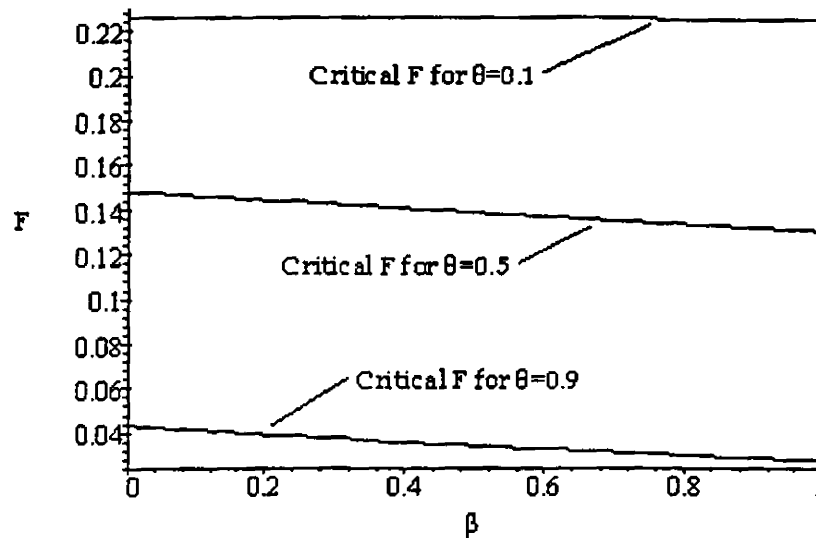
Figure Thirteen - Interaction of θ and β



One can see that as θ increases the critical level of β increases. A higher degree of substitutability means that the gains from trading in the market have to be much larger. This is because an increasing θ leads to lower product market profits when predating and therefore the trading profits have to be very large to ensure that the predation strategy is optimal.

The cut-off level of sunk costs is also affected by θ . As was shown earlier, if $\frac{(\theta+2)^2(1-\theta)}{(4-\theta^2+\beta\theta^2)^2(\theta+1)} < F$, then Firm B will exit the market. The diagram below shows the critical levels of sunk costs for differing levels of θ . the top line shows, $\theta = 0.1$, the middle line $\theta = 0.5$ and the bottom line $\theta = 0.9$. One can see that on the diagram below the derivative of this condition with respect to θ is negative. As θ increases the critical level of sunk costs falls. This is because an increasing θ denotes an increasing level of competition and therefore lower profits. With Firm B making lower profits it is easier to predate it out of the market.

Figure Fourteen - Effect of θ on Critical Fixed Costs Level



4. EXECUTIVE REMUNERATION AND COMPETITION LAW BREACHES

4.1. Introduction

The separation of ownership and control in large firms is an integral part of the modern economy. This classic principal-agent problem is usually ameliorated by the use of executive compensation contracts that aim to align the interests of executives and shareholders. Executive compensation and pay-performance relations have been studied at length and Murphy (1999) provides a summary. The incentives facing the CEO are important because, given this split between ownership and control, it is the executives of the firm that choose the firm's strategy and decide which sectors to invest in, how to finance the firm and, as studied here, whether to break the competition laws. Any firm breaking the UK competition laws ran the risk of being reprimanded by the competition authorities, and repeated breaches of the Restrictive Trade Practices Act (1976) led to company fines, personal fines and the threat of jail sentences. Breaking the law was therefore a risky strategy and risk averse executives would have desired some compensation for these risks. This is the main hypothesis tested in this paper.

Hypothesis One: that the executives in firms that broke the UK competition laws received higher remuneration, *ceteris paribus*.

This hypothesis is tested on an unbalanced matched sample that runs from 1977 to 1997. The sample compares executive compensation in the reprimanded firms during the ten years before they were reprimanded with executive compensation in a matched sample of firms that did not break the law.

Since I also have data on the reprimanded firms for the period after they were reprimanded I am able to test a second, related, hypothesis. After the reprimand the reprimanded firms should not have been breaking the competition laws, so there should have been no extra compensation for the executives. This is hypothesis two.

Hypothesis Two: after they were reprimanded, the firms that broke the UK competition laws paid equivalent remuneration to their executives, *ceteris paribus*.

The results of the pre-reprimand sample show that both total directors' remuneration and the remuneration of the highest paid director were significantly higher. These results support the hypothesis that when executives break the law they are compensated for the extra risk.

The results in the post-reprimand sample show that total remuneration of the board of directors was significantly higher, but highest director's salary was not significantly higher. The results for highest director's salary support the hypothesis, but the results for total board remuneration do not. Some potential explanations for these results are discussed in Section 6.

The rest of this paper is laid out as follows. Section 2 details the hypotheses and describes competition law in the UK between 1977 and 1997. Section 3 describes the data collection process. Section 4 contains the results of the pre-reprimand analysis and Section 5 contains the results of post-reprimand analysis. Section 6 considers some alternative explanations for the results and Section 7 concludes.

4.2. Theory

In this section I lay out the theory behind the hypotheses and briefly describe UK competition law during the sample period.

4.2.1. The Expected Costs of Breaking the Law

This section discusses the expected costs an executive faced when deciding whether to break the UK competition laws between 1977 and 1997. I consider the differences between a standard investment project, e.g. opening a new factory, and deciding to break the competition laws e.g. joining a cartel. The upsides are very similar: the firm increases its profits. The difference lies in the downside risks. The downside risks can be split into two different types: personal fines or imprisonment, and reductions in the executive's future earnings.

Personal fines could only be imposed on the executives that repeatedly broke the Restrictive Trade Practices Act, an act that controlled agreements between firms. When a director attempted to enforce an agreement that the court had already annulled they were found

guilty of contempt court and fined individually. This cost has no parallels in normal business projects. One could argue that these fines were only imposed after the second offence, and therefore there were no additional costs involved in breaking the law the first time. This is mistaken, as being caught once increases the probability of being fined in the future, even if this only through a mistake by the court.

The second cost of breaking the law is less direct, and involves the reputation of the executive. Any executive who has been delivering high profits will be well regarded by the owners of the firm, and the owners of other firms. These shareholders will base their valuation of the executives on many factors, but the shareholders will be unable to tell whether the executive is breaking the law. The shareholders will see the profit level, but will be unable to tell whether those profits are derived from illegal or legal actions by the executive. Since it is a possibility that the executive is breaking the law to deliver these profits this will be factored into the estimation of the value of the executive. The executive's value to the shareholders will be a weighted average of two values. The first value will be the value of the executive if he is acting legally, call it V_L . The second value will be the value of the executive if he is acting illegally, call this V_I . V_I will be lower than V_L because the profits delivered are less likely to continue and the illegal actions may result fines in the future. If α is the owners' estimate of the probability that the executive is acting legally the value of the executive will be given by the following formula:

$$\text{Initial Value of Executive} = \alpha V_L + (1 - \alpha) V_I$$

After an executive has been caught breaking the law the owners will update their beliefs and the value of α will become zero, and the new value of the executive will be V_I . This is a fall in the value of the executive because $V_L > V_I$. Since the owners now value the executive less highly he will receive lower remuneration. The possibility of this reduction in remuneration is a definite cost for the executive.

This fall in value will not occur if a normal investment project does not deliver higher profits, as no updating of the executive's value will occur. Therefore this fall in value is a cost solely associated with acting illegally.

In sum, it is clear that there is some cost involved in breaking the law. All that remains is to show that the legal risk faced by executives were constant throughout the sample period of 1977 to 1997. This is done below.

4.2.2. UK Competition Law

In 1976 the Restrictive Trade Practices Act (RTPA) became law. The Act introduced a system of compulsory registration and all agreements that met the criteria set out in the RTPA had to be registered with the Office of Fair Trading (OFT). The OFT then assessed the agreements and the restrictions they entailed. When the OFT decided to challenge the restrictions it brought a case before the Restrictive Practices Court. If the Court decided that the agreements harmed consumers and provided no other compensatory benefits then the agreement was struck down, but no fines were imposed. Fines were only imposed if the parties repeated the offence. Repeated offences were deemed contempt of court and the court then had the power to fine the companies and the individual executives faced fines or imprisonment. The 1995 Annual Report of the Director General of Fair Trading gives an example of the court fining individuals:

"Record fines totalling £8,735,000 (plus costs) were imposed on the companies themselves, while five directors who were found to have aided and abetted the contempt were ordered to pay £87,500 in fines and costs. The other two directors were acquitted.... The judge made it clear that individuals who were found guilty of similar offences in the future should expect to go to prison for a significant period." (p.40).

The Fair Trading Act (FTA) of 1973 and the Competition Act of 1980 covered abuses of a dominant position. The Fair Trading Act dealt with anti-competitive practices or 'scale monopolies'. If the OFT or the Monopolies and Mergers Commission (MMC and now the Competition Commission) thought the firm was acting anti-competitively then a lengthy investigation was launched. At the end of this procedure the firm could only be told to cease the actions. No fines could be imposed under the FTA or the Competition Act.

In addition to covering abuses by individual firms the FTA also sanctioned investigations of 'complex monopolies'. These provisions allowed the MMC to investigate whole industries rather than firms - there was no need for a single firm to have a dominant position.

Following investigation the MMC could only require the firms to cease the actions that the MMC deemed to be anti-competitive and again no fines could be imposed.

The FTA and the RTPA were in force throughout the sample period, from 1977 to 1997. The Competition Act became law in 1980 but had no effect on the penalties, it only changed the procedure and criteria for investigating dominant positions. In short, the legal risks faced by executives breaching the competition laws were almost constant between 1977 and 1997.

4.2.3. Relevant Literature

Asch and Seneca (1976) was the first paper to compare firms that broke the competition laws with those that did not. They tested a sample of firms that were involved in US cartels and found that the firms in the cartels were less profitable than comparison firms. Papers following the same path include Choi and Philippatos (1983) and Feinberg (1980).

The literature on executive compensation is vast. The basic empirical results are that executive compensation is closely linked to the size of the firm and that performance sensitivities are small but significant. Murphy (1999) provides a summary. UK papers analysing executive compensation include: Conyon (1997), Conyon and Leech (1993), Conyon and Murphy (2000), Conyon and Nicolitsas (1998), Cosh (1975), Cosh and Hughes (1997) and Gregg et al. (1993).

Cosh and Hughes (1997) is the paper that is closest to the current paper. Their paper examines the links between executive pay and institutional shareholdings. The authors find that the presence or absence of major institutional shareholders has no effect on the level of remuneration or the likelihood of dismissal.

4.3. Data

In this section I lay out the method used to form the sample of reprimanded and innocent companies. The primary aim of the selection methodology was to reduce the probability of Type I and Type II errors: the problem of incorrectly classifying innocent and reprimanded firms. This is very important in the area of competition law, as there are few 'bright lines' dividing legal from illegal practices.

The Annual Report of the Director General of Fair Trading gives a detailed description of the work of the OFT and the MMC during the year. I examined the reports from 1978 to 1999 and collected the names of the companies that had been reprimanded by the OFT, the MMC, or the Restrictive Practices Court. These are the three types of reprimand I used as evidence of a breach of UK competition laws.

The first type of reprimand is a decision by the Restrictive Practices court. The Annual report of 1990, on p.111 states:

"On 30 November, the Restrictive Practices Court took action against 41 companies which had been parties to 12 price fixing agreements in the glass manufacturing and glass distribution industries...Confirming that the agreements were against the public interest, the court accepted the undertakings from some of the companies not to enforce these price restrictions or to enter into similar agreements and made orders to the same effect against the remainder."

The second type of reprimand is a report by the Monopolies and Mergers Commission. An example of this appears on p.39 of the 1994 report, which states:

"Following a report by the MMC in 1992, Bryant and May Ltd. gave undertakings to the Secretary of State giving effect to a freeze on the price of matches and prohibiting the inclusion - in future agreements with its customers - of provisions on discounts, exclusive sales, promotional activity and minimum stocking likely to strengthen its position and weaken that of its competitors."

The third type is a reference or report by the Director General of Fair Trading, an example of this is on p.87 of the 1984 Annual Report, which states

"The Director General has published a report under section 3 of the Competition Act 1980 (the Act) stating that a course of conduct pursued by Ford Motor Company Limited (Ford) constitutes an anti-competitive practice..."

Collecting these types of reprimands between 1977 and 1997 led to a list of 268 infringements. The fact that the actions of these companies were only deemed wrongful after a detailed investigation minimises the probability of a Type I error (the probability that these firms were acting legally and were mistakenly reprimanded by the authorities).

These 268 companies were then cross-referenced with the data available from Datastream. For each of the companies I attempted to obtain accounting data for the ten year period before the decision of the competition authority. Since many of the companies in the sample were subsidiaries of a non-UK corporation, or were not quoted, there was a notable reduction in the pre-reprimand sample size. I was able to obtain accounting data for 23 of the companies that were reprimanded. The first company I have data for is BPB (British Plasterboards). BPB was reprimanded in 1978 so I use data from 1977 to 1978. Dixons appears in the 1998 report but was reprimanded in 1997, so the Dixons data runs from 1988 to 1997.

The comparison sample was built using the matching technique. For every reprimanded firm I obtained its industry grouping according to the Financial Times newspaper. I then compared the total sales of each reprimanded company with the total sales of the companies in the same industry grouping. The two firms whose sales were the closest to the reprimanded firm over the sample period were then chosen, and wherever possible I picked one firm with slightly larger sales and one firm with slightly smaller sales. A number of checks were then made on the chosen 'innocent' firms.

First, I made sure that the comparison firm was not subject to any regulation of its activities or was recently privatised. Joskow, Rose and Shepard (1993) show that the level and structure of executive pay differs in regulated and non-regulated firms, at least in the US. Wolfram (1998) shows that the average level of chief executive remuneration in the twelve UK regional electricity distribution companies nearly tripled in the two years following privatisation. Since these effects could influence the results no regulated or recently privatised firms were included.

Second, all the matched firms were checked to see whether they had been involved in any illegal activity. The fear here is that a firm chosen as 'innocent' may actually have been breaking the law but was never caught. In an attempt to prevent Type II errors (incorrectly classifying guilty firms as innocent firms) the following checks were carried out.

1. All matched firms were cross-referenced to see if they appeared in the Annual Reports of the Director General of Fair Trading. If they were mentioned (apart from those who were cleared by merger investigations) they were rejected.
2. All matched firms were fed into the search engines of the Office of Fair Trading website, the Competition Commission website, Competition Directorate-General website, and the general UK government website. If these searches returned any malfeasance then the companies were rejected.

For every one of the comparison firms that was rejected I chose the next closest firm and repeated the above procedure. Unfortunately, for some of the companies I could find only one matching firm that fulfilled the above criteria. In addition, there were no matches for GEC-Marconi in the Information Technology Sector. I therefore chose its comparison firms from the Financial Times' Aerospace and Defence Sector.

A similar methodology was used for the post reprimand sample. The only differences were the following:

1. I used data for the period following the reprimand, up to the year 1999.
2. BPB was dropped because it was reprimanded for a second time by the Monopolies and Mergers Commission in 1990¹.
3. Empire Stores was removed from the sample because of its takeover by the Kingfisher Group.

4.4. Pre-Reprimand Analysis

This section covers the analysis of the pre-reprimand sample. First comes a description of the data. This is followed by a profitability analysis and then the executive compensation analysis.

¹ "The Commission found that BPB's past conduct has not always stayed with the boundaries of fair competition." Director General of Fair Trading's Annual Report 1990, page 80.

4.4.1. Summary Statistics

The table below contains the summary statistics for the data (all figures in thousands of UK 1990 pounds). I represents the innocent firms and R the reprimanded firms.

Table 4.1
Pre-Reprimand Sample Summary Statistics I=Innocent, R=Reprimanded

Figure	Mean	Media	Std. Dev	Max	Min	Obs.
I- Total Assets	787,778	415,242	992,065	4,173,749	5,462	361
R- Total Assets	2,178,212	1,071,921	3,297,221	1.38x10 ⁷	11,316	164
I- Total Sales	1,042,366	444,052	1,331,675	6,330,337	3,989	361
R-Total Sales	2,608,870	1,441,419	4,216,761	2.50x10 ⁷	20,924	164
I- Number of Employees	11,171	5,865	14,702	71,319	90	251
R= Number of Employees	25,255	10,326	39,426	157,000	324	97
I-Total Fixed Assets	456,389	210,148	722,894	4,615,073	1,028	361
R- Total Fixed Assets	1,440,561	372,290	2,536,007	1.07x10 ⁷	4,700	164
I- Dir. Remuneration	913	686	856	5,649	79	361
R- Dir. Remuneration	1,715	1,213	1,939	9,089	107	164
I- Highest Remuneration	184	134	190	1,177	29	318
R- Highest Remuneration	242	176	201	1,577	34	143
I-ROA (Adj.)(%)	5.36	5.59	3.45	13.74	-14.38	361
R-ROA (Adj.)(%)	6.76	5.96	4.65	22.50	-2.3	164
I- Trading Profit Margin (%)	8.01	7.07	6.61	44.55	-19.71	361
R- Trading Profit Margin(%)	8.90	7.91	7.16	41.36	-1.62	164

When the means are compared one can see that the reprimanded firms are larger in terms of total assets, total sales and number of employees. The mean sales for the reprimanded firms

were £2.6 billion, while the sales of the innocent firms were £1 billion. The large differences in size were driven by problems encountered in the matching process. First, three of the reprimanded firms were in the Food Producers and Processors Group (Unilever, Hillsdown Holdings, and Cadbury-Schweppes). Since Tate and Lyle was fined 7 million ECU by the European Commission in 1998, and a subsidiary of Booker was fined by the UK Environmental Agency in 1998, both these firms could not be included in the list of innocent firms. The remaining firms in the Food Producers and Processors Group are much smaller than the reprimanded firms, thus contributing to the imbalance in size. Similarly, BASS is much larger than the other brewers in its group.

Dir. Remuneration is the remuneration of the whole board of directors and includes the salary, bonuses and pension contributions of all the board. The mean level of remuneration in the innocent firms was £913,000, while the level in the reprimanded firms was £1,715,000. The highest level of real remuneration in an innocent firm was £5.6 million. This was paid to the board of Marks and Spencer PLC in 1993. The highest real level of remuneration in a reprimanded firm, £9.1 million, was paid to the board of Unilever in 1978.

Highest Remuneration is the remuneration of the highest paid executive on the board and this is usually the Chief Executive Officer. This figure includes salary, pension contributions and bonus. The level of real mean pay in the innocent firms was £184,000, while in the reprimanded firms it was slightly higher at £242,000. The lowest paid executive worked for Williams in 1981 and was paid a real sum of £29,000. The highest paid executive of the sample of innocent firms was an executive of BOC in 1985, and received a real sum of £1.117 million. The highest paid executive of a reprimanded firm, receiving a real sum of £1.577 million, was on the board of Dixons in 1997. The year the then MMC released a report stating that the actions taken by Dixons 'operated or may be expected to operate against the public interest'.²

ROAADJ is measured as $\frac{100 \times \text{Adjusted After Tax Profit}}{\text{Total Assets}}$. As can be seen, the mean figure for the innocent firms is 5.36%, while the figure for the reprimanded firms is 6.76%. The higher profitability of the reprimanded firms also appears in the Trading Profit Margin figures of

² Domestic electrical goods I: a report on the supply in the UK of televisions, video cassette recorders, hi-fi systems and camcorders by the Monopolies and Mergers Commission. Published 30.7.97.

the two groups. The mean figure for the reprimanded firms is 8.90% while for the innocent firms it is 8.01%. These figures are investigated in the next section.

4.4.2. Profitability

As a prelude to the main results I investigate in more depth the profitability figures discussed above. The intuitive belief is that firms that break the law do so to increase their profits. I therefore test whether this is true by estimating the following model:

$$ROAADJ_{it} = \beta_1 + \beta_2(REPRIMANDED)_i + \beta_3 X_i + \beta_4 Y_t + \varepsilon_{it}$$

Where X_i is a set of dummies to control for industry fixed effects and Y_t controls for year fixed effects. Reprimanded is a dichotomous variable that takes on the value 1 if the firm was reprimanded for breaking the competition laws and 0 if not. The results are shown in the table below:

Table 4.2
Results of Profitability Analysis- Pre-Reprimand Sample

Variable	Coef.	Robust Std. Error ³	t-stat
Constant	6.44	1.13	5.68
REPRIMANDED	1.48	0.34	4.38
Chemicals	-0.75	0.66	-1.13
Construction	-0.71	0.62	-1.14
EEE	0.95	0.78	1.22
Food Processors	0.77	0.55	1.40
General Retail	0.27	0.54	0.49
IT	2.20	0.72	3.04
Pharmaceuticals	4.62	1.00	4.64
Pubs & Brewing	-0.15	0.64	-0.23
Steel	-2.59	0.99	-2.61
Support Services	0.81	0.93	0.87

Dependent Variable: $\frac{100 \times \text{Adjusted After Tax Profit}}{\text{Total Assets}}$, $R^2=0.32$, Obs. =525

The constant represents the value for the transport industry. So the average firm in the transport sector that did not break the competition laws had a return on total assets of 6.44%. The coefficient for reprimanded is positive and significant. The ROA of the reprimanded firms was, on average, $(\frac{1.48}{6.44} \times 100) \approx 23\%$ higher than that of the innocent firms.

The other coefficients show the differences between the industries. The pharmaceuticals sector was the most profitable.

A similar regression was run with Pretax Profit Margin as the dependent variable, the results of this are given below:

Table 4.3
Results of Profitability Analysis- Pre-Reprimand Sample

Variable	Coef.	Robust Std. Error ⁴	t-stat
Constant	15.07	3.23	4.66
REPRIMANDED	1.27	0.51	2.52
Chemicals	-4.76	2.01	-2.36
Construction	-5.19	2.00	-2.60
EEE	-2.20	2.12	-1.04
Food Processors	-7.21	1.93	-3.74
General Retail	-6.03	1.99	-3.03
IT	-1.12	2.13	-0.52
Pharmaceuticals	5.94	2.60	2.28
Pubs & Brewing	0.79	2.00	0.40
Steel	-9.17	1.96	-4.66
Support Services	-4.13	2.21	-1.87

Dependent Variable: Pretax Profit Margin, $R^2=0.32$ Obs.=525

Again the results show that the reprimanded firms were significantly more profitable. The Pretax Profit Margin of the reprimanded firms was approximately $(\frac{1.27}{15.07} \times 100) \approx 8\%$ higher.

The results show that the average in the transport sector was 15.07%, while the figure in the

³ Calculation of robust standard error follows White (1980).

⁴ Calculation of robust standard error follows White (1980).

steel sector was significantly lower at $(15.07 - 9.17 = 5.90\%)$. Again, according to this measure, the pharmaceuticals sector is the most profitable.

The results here contrast with Asch and Seneca (1976), who find that after controlling for other variables collusive behaviour is negatively associated with profitability. This difference may be because Asch and Seneca (1976) compared firms in cartels and those not in cartels. Here the sample contains firms that were abusing a dominant position. It could be argued that abusing a dominant position leads to significantly higher profitability. Therefore, given these higher profit levels, it is important that when we test the hypotheses on executive remuneration we control for profitability.

4.4.3. Executive Compensation

4.4.3.1. *Individual Executive Remuneration*

In this section I use Highest Director's Remuneration as the dependent variable. This proxy for executive remuneration includes salary and bonus but does not include the value of options or changes in the value of share holdings. Joskow and Rose (1994) report that bonuses are usually tied to accounting criteria, so I use accounting measures of profitability rather than share based measures of shareholder return in the following analysis.

Two major caveats should be borne in mind when interpreting the results that follow. First, many US studies include the personal characteristics of the CEO, such as the length of tenure, the age of the executive, or the age of the executive squared as independent variables. Rose and Sheperd (1997), for example, include age at appointment, tenure as CEO, outside hire, and company founder as independent variables. To my knowledge the only UK study that contains this type of data is Conyon and Murphy (2000). Their UK data cover the 1997 fiscal year for 510 companies. In their study the coefficients for CEO age and CEO age squared are both significant. To the extent that these omitted variables are correlated with the error term in the model below the estimates presented below will be biased. The second caveat is that highest director's salary is not disclosed for some of the companies. If there is correlation between the level of the remuneration and the lack of willingness to disclose it the results below will again be biased.

I estimate four equations based on the following structure:

$$\ln(HDS)_{it} = \beta_1 + \beta_2 \ln(SIZE)_{it} + \beta_3 (PROFITABILITY)_{it} + \beta_4 X_i + \beta_5 Y_t + \beta_6 (REPRIMANDED)_i + \varepsilon$$

$\ln(HDS)$ is the natural log of Highest Director's Remuneration. Size is measured either as Total Assets or Total Sales. Profitability is measured either as $\frac{100 \times \text{Adjusted After Tax Profit}}{\text{Total Assets}}$ or the Pretax Profit Margin. X_i is a set of industry dummies and Y_t controls for year fixed effects. Reprimanded is a dichotomous variable that takes on the value 1 if the firm was reprimanded for breaking the competition laws and 0 if not.

Table 4.4
Results of Individual Executive Compensation Analysis - Pre-Reprimand Sample

Variable	Coef.	Coef.	Coef.	Coef.
$\ln(\text{Total Assets})$	0.268 (0.010)		0.270 (0.011)	
$\ln(\text{Total Sales})$		0.264 (0.010)		0.265 (0.010)
ROA(%)	0.028 (0.005)	0.027 (0.005)		
Pre-tax Profit Margin(%)			0.010 (0.003)	0.019 (0.003)
Reprimanded	0.117 (0.038)	0.108 (0.038)	0.148 (0.039)	0.125 (0.037)
R-Squared	0.80	0.78	0.79	0.78
Obs.	461	461	461	461

Dependent Variable: $\ln(\text{Highest Director's Salary})$. Robust Standard Errors in parentheses.

The results for size closely follow the literature. Rosen (1992) summarises a number of studies and reports pay-size elasticities between 0.2 and 0.35. Here the coefficient of 0.264 for total sales in the second regression means that a 10% rise in size will lead to a 2.64% rise in the remuneration of the highest paid executive. Evaluated at the means this implies that increasing sales from £1.531 billion to £1.684 billion would lead to an increase in remuneration from £202,122 to £207,458 an increase of £5,336. The ROA coefficient is also significant, showing that there is significant pay-performance sensitivity. The estimated

coefficient of 0.028 in the first regression means that increasing ROA by 5% (e.g. from 10% to 10.5%) would lead to pay increasing by 0.14%. The coefficient for reprimanded is significantly different from zero, and shows that the executives in the reprimanded firms are paid between and 11.4% and 16% more, depending on the independent variables chosen.⁵

In general the regressions give remarkably similar results and thus we can be confident in drawing conclusions from the data. It is clear that the data support the hypothesis that the highest paid executives in firms that broke the law were rewarded for the extra risks they faced.⁶

4.4.3.2. *Board Remuneration*

In this section I use total board remuneration as the dependent variable. Although the majority of empirical papers use the remuneration of individual executives as the dependent variable I include total board remuneration for three main reasons.

First, as stated above, the results above for individual executives may be biased, either by the non-inclusion of individual CEO characteristics as independent variables, or because of non-disclosure of highest director's remuneration. With respect to the first problem, since the board contains a number of directors it is less likely that the personal characteristics of individual board members will have an effect on total board remuneration. There is therefore less chance that the estimates presented below are contaminated by omitted variable bias. With respect to the second problem total board remuneration is always disclosed so there is no non-disclosure bias.

Second, if the firm is breaking the law then many of the executives will have to be compensated for the risk.

I estimate the same econometric models as above but this time use total board remuneration as the dependent variable. The results are presented below:

⁵ Calculated as $e^{\beta_0} - 1$

⁶ The sample above contains the guilty firms and those innocent firms that were matched in the pre-reprimand period. If instead we take the comparison firms that were matched over the post-reprimand period and use their data in the above regressions the estimated guilty coefficients were no longer significant. This is probably due to the poor match.

Table 4.5
Results of Board Remuneration Analysis - Pre-Reprimand Sample

Variable	Coef.	Coef.	Coef.	Coef.
ln(Total Assets)	0.430 (0.011)		0.436 (0.011)	
ln(Total Sales)		0.430 (0.012)		0.424 (0.012)
ROA(%)	0.007 (0.005)	0.006 (0.005)		
Pre-tax Profit			-0.002 (0.003)	0.136 (0.003)
Margin(%)				
Reprimanded	0.140 (0.038)	0.124 (0.040)	0.148 (0.038)	0.121 (0.038)
R-Squared	0.86	0.84	0.86	0.84
Obs.	525	525	525	525

Dependent Variable: ln(Total Board Remuneration). Robust Standard Errors in parentheses.

As before, the results from the different regressions are remarkably similar. The size of the firm is the driving factor, with profitability having a small and often insignificant effect. No explanation can be given for the differences when Pre-tax Profit Margin is used as an independent variable. With regard to the hypothesis tested the estimated reprimanded coefficient is significantly different from zero in all the regressions and ranges from 0.121 to 0.148, implying differences in total board remuneration of 12.9% to 15.0%. The data here support the hypothesis that executives are compensated for the risks involved in breaking the competition laws.

The significantly higher total board remuneration could be driven by two factors: either larger boards, or higher average board remuneration for the individual executives. Further regressions were run and the results of these showed that average board remuneration was positively and significantly related to the reprimanded dummy variable, but that board size was not related. Another potential problem is that the extra pay of the highest director's salary drives the results obtained for total board remuneration. To test this I created a new variable, which was the equal to

Total Executives Remuneration - Highest Directors Salary
Number of Executive minus 1

When the natural log of this variable was used as the dependent variable in the regressions above the reprimand coefficients were of a similar magnitude and significant. In sum, the results support the hypothesis that all the executives on the board obtain premiums for the risks associated with breaking the competition laws.⁷

4.5. Post – Reprimand Analysis

This section is concerned with the question of whether the executives in the firms that were reprimanded continued to receive higher remuneration after the reprimand. In this sample we assume that the previously reprimanded firms are no longer contravening the competition laws, so there should be no extra risks that require compensation. As before I begin with the summary statistics of the post reprimand sample.

4.5.1.1. *Summary Statistics*

The table below contains the summary statistics for the data (all figures in thousands of UK 1990 pounds). I represents the innocent firms and R the previously reprimanded firms.

⁷ The sample above contains the guilty firms and those innocent firms that were matched in the pre-reprimand period. If instead we take the comparison firms that were matched over the post-reprimand theory and use their data in the above regressions the estimated guilty coefficients were of a similar magnitude and significant.

Table 4.6
Post Reprimand Sample Summary Statistics I=Innocent, R=Reprimanded

Figure	Mean	Media	Std. Dev	Max	Min	Obs.
I- Total Assets	1,050,605	551,312	1,407,110	6,720,069	9,754	306
R- Total Assets	3,440,408	2,075,590	3,940,948	1.78x10 ⁷	10,770	158
I- Total Sales	1,416,438	716,822	1,625,902	6,545,552	12,251	306
R-Total Sales	39,066,651	2,240,519	5,414,175	2.36x10 ⁷	18,395	158
I- Number of Employees	13,833	8,357	18,182	73,689	147	132
R= Number of Employees	32,815	12,356	41,036	145,346	219	68
I-Total Fixed Assets	561,767	273,399	843,442	4,128,458	5,948	306
R- Total Fixed Assets	2,177,452	1,210,719	2,691,141	1.06x10 ⁷	7,488	158
I- Dir. Remuneration	1,460	1065	1,588	9,858	116	306
R- Dir. Remuneration	2,250	1816	2,305	12,947	202	158
I- Highest Remuneration	348	232	353	2,378	56	304
R- Highest Remuneration	460	371	367	2,159	49	158
I-ROA(Adj.)(%)	5.56	5.94	5.27	17.45	-35.10	306
R-ROA(Adj.)(%)	7.00	6.88	4.48	19.91	-7.33	158
I- Trading Profit Margin (%)	7.03	6.22	7.25	46.25	-34.34	306
R- Trading Profit Margin(%)	9.54	7.95	8.11	39.35	-6.04	156

As in the pre-reprimand sample the reprimanded firms are considerably larger in terms of total assets, total sales and number of employees. Again the imbalances in the Food Producers and Processors sector are the main reasons for this.

The mean of Directors' remuneration was higher in the previously reprimanded firms. The highest level of real remuneration in an innocent firm was £9.858 million. This was paid to

the board of Smith-Kline Beecham in 1996. The highest level of real total director remuneration was £12.947 million. The board of Glaxo earned this amount in 1993.

Highest Remuneration gives the sum of salary plus bonus for the highest paid director in a firm. The mean real remuneration in the innocent firms was £348,000, while in the reprimanded firms it was £460,000. The lowest paid highest paid executive worked for the construction company Alexander Russell in 1982 and was paid a real sum of £56,000. The highest paid executive in the sample of innocent firms was an executive of Smith-Kline Beecham, who received the real sum of £2.378 million in 1995. The lowest paid highest paid executive of a reprimanded firm worked for Gibbs and Dandy and was given a real value of £49 000 in 1992. The highest paid executive in the reprimanded sample was an executive of Glaxo-Wellcome, who received £2.159 million in 1995.

ROAADJ is measured as $\frac{100 \times \text{Adjusted After Tax Profit}}{\text{Total Assets}}$. As can be seen, the mean figure for the

innocent firms is 5.56%, while the figure for the reprimanded firms is 7.00%. This shows that even after they were reprimanded for breaking the competition laws the reprimanded firms continued to be more profitable. The higher profitability of the reprimanded firms also appears in the Trading Profit Margin figures of the two samples. The mean figure for the reprimanded firms is 9.54% while for the innocent firms it is 7.03%. This figure of 9.54% is actually higher than the figure for the reprimanded firms when they were breaking the law (8.90%), showing that the reprimand had few negative effects on the profitability of these firms. This result is mirrored in the ROAADJ figures, before the reprimand the figure for the reprimanded firms was 6.76%, while after the reprimand the figure was 7.00%. These profitability figures are investigated in more depth in the next section.

4.5.2. Profitability

In this section I further investigate the profitability figures mentioned above. To test whether there are significant differences between the previously reprimanded firms and the matched firms I estimate the following model

$$ROAADJ_{it} = \beta_1 + \beta_2(REPRIMANDED)_i + \beta_3X_i + \beta_4Y_i + \varepsilon_{it}$$

Where X_i is a set of dummies to control for industry fixed effects and Y_i controls for year fixed effects. Reprimanded is a dichotomous variable that takes on the value 1 if the firm was reprimanded for breaking the competition laws before the sample period and 0 if it was not. The results were the following:

Table 4.7
Results of Profitability Analysis- Post-Reprimand Sample

Variable	Coef.	Robust Std. Error ⁸	t-stat
Constant	2.65	0.76	3.48
REPRIMANDED	1.60	0.39	4.11
Chemicals	0.71	0.71	0.99
Construction	-0.34	0.59	-0.59
EEE	0.19	0.63	0.31
Food Processors	1.12	0.54	2.06
General Retail	3.38	0.56	5.97
IT	3.40	0.74	4.57
Pharmaceuticals	4.78	1.71	2.79
Pubs & Brewing	-0.32	0.58	-0.55
Steel	-5.97	1.45	-4.09
Support Services	2.59	0.78	3.30

Dependent Variable: $\frac{\text{Adjusted After Tax Profit}}{\text{Total Assets}}$, $R^2=0.32$ Obs.=464

The constant represents the value for the transport industry. So the average firm in the transport sector that did not break the competition laws had a return on total assets of 2.65%. The coefficient for reprimanded is positive and significant. The ROA of the reprimanded firms was, on average, $(\frac{1.60}{2.65} \times 100) \approx$ approx 60% higher than that of the innocent firms. This compares with the 23% that occurred before the firms were reprimanded. The other coefficients show the differences between the industries. Again the Pharmaceuticals sector is the most profitable.

⁸ Calculation of robust standard error follows White (1980).

A similar regression was run with Pretax Profit Margin as the dependent variable, the results of this are given below:

Table 4.8
Results of Profitability Analysis- Post-Reprimand Sample

Variable	Coef.	Robust Std. Error ⁹	t-stat
Constant	10.98	3.05	3.60
REPRIMANDED	2.66	0.58	4.58
Chemicals	-5.22	2.93	-1.78
Construction	-7.42	2.83	-2.62
EEE	-5.07	2.85	-1.78
Food Processors	-7.38	2.82	-2.61
General Retail	-1.11	2.92	-0.38
IT	-2.08	2.92	-0.71
Pharmaceuticals	5.39	4.17	1.29
Pubs & Brewing	-2.65	2.90	-0.92
Steel	-12.84	2.89	-4.46
Support Services	-4.54	2.90	-1.56

Dependent Variable: Pretax Profit Margin, R²=0.35 Obs.=462

Again the results show that the reprimanded firms were significantly more profitable. The Pretax Profit Margin of the reprimanded firms was approximately $\frac{2.66}{10.98} \times 100 \approx 24\%$ higher.¹⁰

The results here can be compared with those of Choi and Philippatos (1983). They find that in the US an antitrust indictment led to a reduction in the price cost margin and thus the profitability of the indicted firms, at least for those firms that were not inexperienced violators. For experienced firms, which they define as those firms that were indicted more than once in their sample period, they find that an indictment had no effect on the price cost margin and profitability.

⁹ Calculation of robust standard error follows White (1980).

¹⁰ The sample above contains the guilty firms and those innocent firms that were matched in the post-reprimand period. If instead we take the comparison firms that were matched over the pre-reprimand theory and use their data in the above regressions the estimated guilty coefficients were again significantly larger than zero.

4.5.3. Executive Compensation

4.5.3.1. Individual Executive Remuneration

I now move to the analysis of executive compensation and start with Highest Director's Remuneration as the dependent variable. As stated before, one should keep in mind that there might be omitted variable bias.

I estimate

$$\ln(HDS)_{it} = \beta_1 + \beta_2 \ln(SIZE)_{it} + \beta_3 (PROFITABILITY)_{it} + \beta_4 X_i + \beta_5 Y_t + \beta_6 (REPRIMANDED)_i + \varepsilon_{it}$$

$\ln(HDS)$ is the natural log of Highest Director's Remuneration. Size is measured either as Total Assets or Total Sales. Profitability is measured either as $\frac{100 \times \text{Adjusted After Tax Profit}}{\text{Total Assets}}$ or the Pretax Profit Margin. X_i is a set of industry dummies and Y_t controls for year fixed effects. Reprimanded is a dichotomous variable that takes on the value 1 if the firm was reprimanded for breaking the competition laws and 0 if not.

The results of the various equations are laid out below:

Table 4.9
Results of Individual Executive Compensation Analysis - Post-Reprimand Sample

Variable	Coef.	Coef.	Coef.	Coef.
ln(Total Assets)	0.328 (0.160)		0.327 (0.01)	
ln(Total Sales)		0.318 (0.016)		0.316 (0.016)
ROA(%)	0.019 (0.006)	0.015 (0.005)		
Pre-tax Profit			0.008	0.017
Margin(%)			(0.003)	(0.004)
Reprimanded	0.015 (0.040)	0.071 (0.042)	0.027 (0.041)	0.050 (0.042)
R-Squared	0.77	0.76	0.77	0.77
Obs.	462	462	460	460

Dependent Variable: ln(Highest Director's Salary). Robust Standard Errors in parentheses.

The results above show that there was no significant link between the remuneration of the highest paid executive and whether the firm was previously reprimanded for breaking the competition laws. The reprimanded coefficient is not significant in any of the regressions.¹¹ These results support Hypothesis Two. The firms are no longer breaking the law, so there is no extra risk that requires compensation.

4.5.3.2. Board Remuneration

In this section I use total board remuneration as the dependent variable. As was previously stated, the results in this section should be more reliable due to two factors. First, total board remuneration is less likely to be affected by the individual characteristics of the board members so omitted variable bias is likely to be less severe. Second, total board remuneration is reported for all the years and all the companies, so there will be no bias due to non-disclosure.

¹¹ The sample above contains the guilty firms and those innocent firms that were matched in the post-reprimand period. If instead we take the comparison firms that were matched over the pre-reprimand theory and use their data in the above regressions the estimated guilty coefficients were also not significantly different from zero.

Table 4.10
Results of Board Remuneration Analysis - Post-Reprimand Sample

Variable	Coef.	Coef.	Coef.	Coef.
ln(Total Assets)	0.451 (0.013)		0.458 (0.014)	
ln(Total Sales)		0.441 (0.013)		0.437 (0.012)
ROA(%)	0.017 (0.004)	0.011 (0.004)		
Pre-tax Profit Margin(%)			0.003 (0.003)	0.016 (0.004)
Reprimanded	0.117 (0.039)	0.190 (0.041)	0.133 (0.040)	0.170 (0.041)
R-Squared	0.81	0.80	0.81	0.81
Obs.	464	464	462	462

Dependent Variable: ln(Total Board Remuneration). Robust Standard Errors in parentheses.

With total board remuneration as the dependent variable the results are very different. In all four of the regressions the reprimanded coefficient is significant and positive. The estimated coefficients range from 0.117 to 0.190. This implies remuneration differences of between 12% and 21%.¹²

The other coefficients are as one expects: the size of the firm is the driving factor, with profitability having a small effect. These results reject Hypothesis Two. The board of executives was no longer breaking the law, so there should have been no need for higher remuneration.

Further analysis was carried out on the remuneration of the board of directors. The natural log of average board remuneration was used as the dependent variable in regressions similar to those above. The coefficient for reprimanded was significant and the coefficients were, in the same order as the regressions above, 0.102, 0.139, 0.120 and 0.133, implying that

¹² The sample above contains the guilty firms and those innocent firms that were matched in the post-reprimand period. If instead we take the comparison firms that were matched over the pre-reprimand theory and use their data in the above regressions the estimated guilty coefficients were of a similar magnitude and significantly different from zero.

average board remuneration in the previously reprimanded firms was between 11% and 15% higher. I also investigated the size of the board and the proportion of non-executive directors. There were no significant links between these two variables and whether the firm was reprimanded.

4.6. Alternative Explanations

The regressions on the pre-reprimand sample strongly support the hypotheses. Even after controlling for the higher profitability the executives in the reprimanded firms still receive higher remuneration. The post-reprimand sample results are less encouraging. Although the results show that the highest paid directors did not receive higher remuneration after the reprimand, total board remuneration was significantly higher. Below I study some alternative explanations for these results.

Having a dominant position in a market certainly makes it easier for a firm to break the competition laws. Therefore, having a dominant position could be related to breaking the law. However, it is difficult to see, if profitability is controlled for, why this would lead to higher remuneration for the executives.

A more plausible explanation is the lack of monitoring by shareholders. The descriptive statistics showed that the firms in the reprimanded sample were larger than the firms in the innocent sample. It could be that these larger firms, due to more dispersed shareholdings, were more affected by the public action problem. This gives the executives in these larger firms more scope to extract higher wages and, possibly, more opportunities to break the law. Cosh and Hughes (1997) investigate a similar theme and test whether the presence of institutions holding large proportions of shares affects executive compensation or the possibility of dismissal in the UK. They find that institutional presence has no effects. The results of Cosh and Hughes contrast with those of Bertrand and Mullainathan (2000). They study the effect of large shareholdings on executive compensation in a sample of US oil firms. They find that in those firms with more closely held equity the CEOs were rewarded less for exogenous factors that caused increases in share prices, in this case increases in the price of crude oil. These results support the view that dispersed shareholdings may allow executives to extract excessive pay, but give no indication as to whether dispersed shareholding provides executives with more scope to break the law.

Another possibility is that although the shareholders cannot condition remuneration on the actions of the executives they may be able to condition on the type of the executives. Some executives may have a reputation for choosing strategies that are close to being defined as illegal. If these aggressive executives deliver higher expected profits, and there is a limited supply of them, then they will be paid more than other, standard, executives. The existence of these aggressive managers could be causal for both the higher remuneration and the breaches of competition policy. In order to test this one would have to obtain the names of the individual directors and then associate them with the breaches of the competition laws. Unfortunately, however, the names of the highest paid executives are not available on Datastream.

Principal-Agent theory gives unclear predictions about the relationship between executive remuneration and breaches of the competition laws. This is mainly because the predictions depend on the type of Principal-Agent model chosen. On the one hand one could use a model along the lines of Holmstrom and Milgrom (1987). They show that if the executives have an exponential utility function, disturbances follow a Brownian motion, and the cost of control is monetary then a linear reward scheme is optimal. This suggests that executive remuneration should vary linearly with profits. However, in this model the principal can only contract upon outcomes, not actions. Therefore, since breaking the law is an action there would be no scope for rewarding the executives. This model predicts that the coefficient of the reprimanded variable in the above executive compensation models should be insignificantly different from zero. On the other hand the principal agent model could be composed of two components, a linear contract that increases remuneration as profits increase, and a bonus for obtaining exceptionally high profits, profits which can only be obtained through breaking the law. This type of model predicts that the coefficient of the reprimanded variable in the above executive compensation models should be significantly different from zero. In this case causality would run from the compensation scheme to the executive breaking the law.

Finally, perhaps the most convincing explanation could be that the firms that were reprimanded continued to break the competition laws in the post-reprimand sample but were never caught by the authorities. This would explain the higher profits and the higher remuneration. However, no evidence exists to support this argument, it is merely speculation.

4.7. Conclusions

The aim of this paper was to investigate the links between competition policy breaches and the remuneration of UK executives. Breaking the competition laws imposes costs on the executives that are higher than the standard costs involved in managing a firm. I test to see whether executives are compensated for this risk.

The results showed that the executives of the law breaking firms were paid a significant premium in the pre-reprimand sample, ranging from 11% to 16% for the highest paid executive and from 13% to 15% for total board remuneration. The results for the pre-reprimand sample strongly support our hypotheses. Breaching the competition laws is risky and the executives are compensated for this extra risk.

In the post reprimand sample total board remuneration in the previously reprimanded firms remained significantly higher (differences of 12-21%), while there were no differences between the remuneration levels of the highest paid executives. The post-reprimand sample results only partly support our hypotheses. Possible alternative explanations for the higher remuneration include a lack of shareholder control in the law breaching firms, or the possibility that the firms continued to break the law but were never caught.

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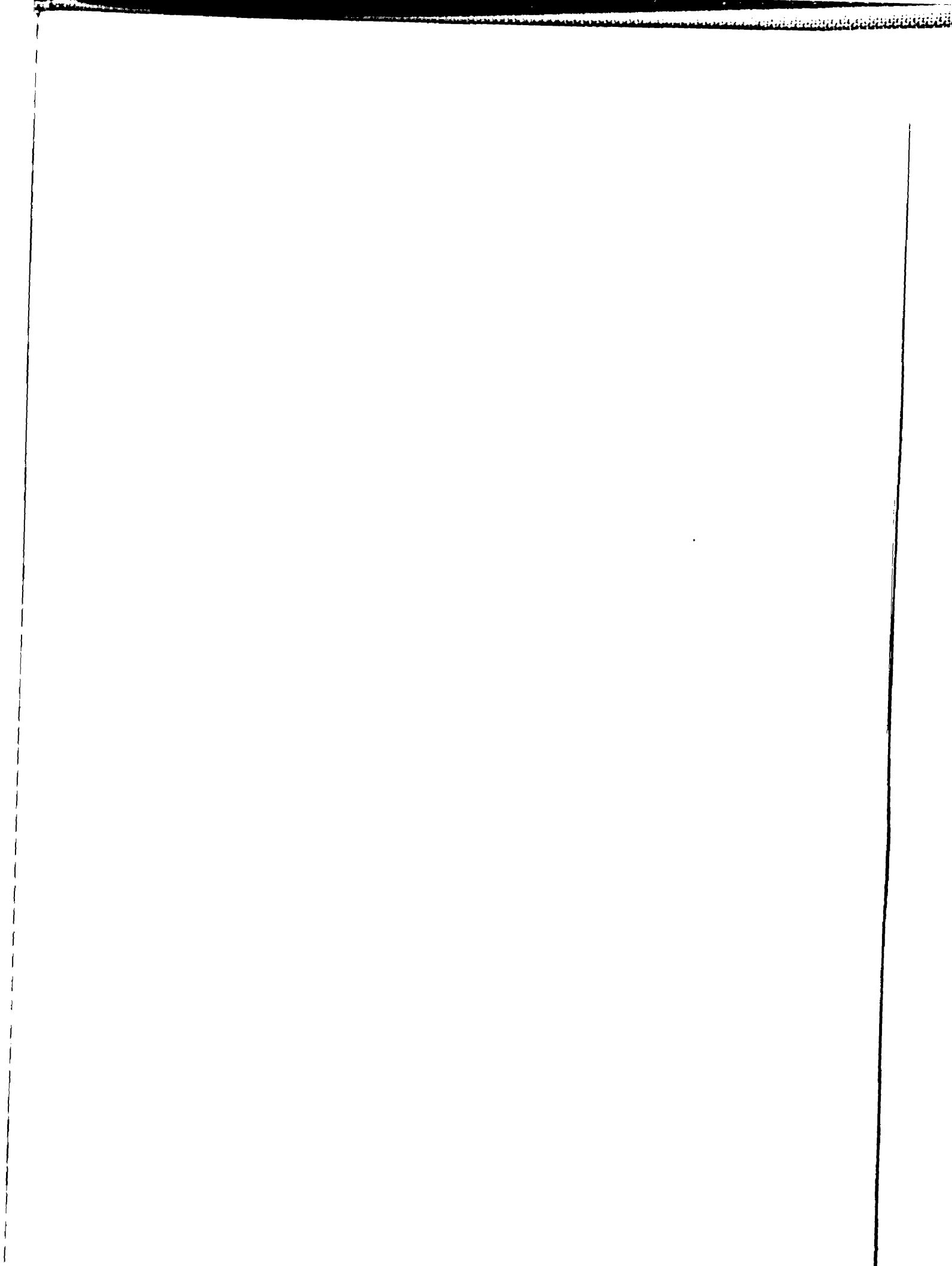
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1. The first part of the document is a list of names and addresses of the members of the committee.



